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SURGERY

BY VARIOUS AUTHORS

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PREFACE

SURGERY is no longer "a mere mechanic art." Out of the old surgery which placed so great a stress upon technique a new surgery is being evolved, a new conception is being formed, the application of which belongs to no passing event, the future of which no one can prophesy.

Functional surgery, if one may use the term, belongs to all the future. Take, for example, abdominal diagnosis, where the mechanism of pain is a question of vast complexity, and the evaluation so essential to diagnosis. Again, the latter-day investigation of anæsthesia opens a new field and warns the surgeon that every function of the nervous system must be given detailed consideration. The study of antiseptics has linked Ehrlich's conception of chemical action with the daily technique of the operating room and extended the domain of bacteriology in the scientific treatment of wounds. It is such advances as these that we have attempted to incorporate with the portrayal of the technique of various surgical clinics. The foundation was found in Burghard's Surgery, whose various contributors in collaboration with the editors have added proved procedures from American clinics and revised the various chapters in the light of the developments in surgical practice produced by experience in war.

The loose-leaf form of the Oxford Surgery will permit the editors to present the future changes in British surgery and incorporate the best thought of the leading American clinics.

The originality and individuality obtained in these volumes will be sought rather than a colourless enumeration of operative procedures. Categorical enumeration of operations of historical interest only and procedures not demonstrated by actual experience to be of value will be avoided.

The editors wish to express to the various contributors and to those whose contributions are being prepared for future insertions the appreciation of the surgeons of America and Great Britain for their unstinted and unselfish labour during a time when they are so occupied by duties necessitated by the exigencies of war.

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SECTION I

HERNIA

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HERNIA

By Carl Goodwin Burdick and Bradley L. Coley

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HERNIA

A HERNIA is a protrusion of portions of the contents of the abdominal cavity through an abnormal opening in its wall. According to the anatomical region in which hernias are located they may be designated as inguinal, femoral, umbilical, ventral, epigastric and more rarely diaphragmatic, obturator, lumbar, sciatic and retroperitoneal.

A hernia may be congenital or acquired. In the former it is due to a developmental defect such as non-obliteration of the processus vaginalis. In the acquired variety the sac has developed after birth and has passed through an opening in the abdominal wall previously intact.

Generally speaking a hernia consists of a sac with its contents and coverings.

The etiology of the various varieties of hernia will be discussed under their respective headings. Suffice it to say here that the principal predisposing cause is, undoubtedly, the existence of a preformed sac. The exciting cause is any increase in intra-abdominal tension.

Hernias may be classified as reducible, a condition in which the contents of the sac may be returned to the abdominal cavity; irreducible, a condition in which the contents of the sac may not be returned to the abdominal cavity. An irreducible hernia is usually one of long standing in which adhesions have formed between the contents of the sac and the sac wall. Omentum is the most frequent offender. Irreducible hernia may be further subdivided into inflamed, incarcerated or obstructed and strangulated. In an *inflamed* hernia there is a peritonitis of the contents of the sac or its walls or both. The authors consider this an unusual condition and one that is very difficult to diagnose.

An *incarcerated* or *obstructed* hernia is one containing intestine, whose lumen is obstructed from within, without any disturbance of the blood supply of its wall, while in a *strangulated* hernia the blood supply of the contents and possibly of the sac itself is partially or completely obstructed. We feel that these two conditions are very difficult and usually impossible to differentiate.

Treatment. The treatment is non-operative and operative.

The *non-operative* consists of some mechanical support as a truss or belt which simply prevents the former contents of the sac from re-entering it. This method in young children under four occasionally affects a cure by the formation of a dense adhesion at the neck of the sac, but we do not advise it after that age. In these same children if the hernia is very large and not comfortably retained by a truss we feel an operation is advisable, unless there is some definite contra-indication.

In all older children and young and middle-aged adults we urge operation as the most satisfactory treatment, unless again there is some very decided contra-indication.

In those patients over sixty each case must be decided on its merits. If the hernia is not very large and easily retained by a comfortable truss and the patient not over-active, we are inclined to let well enough alone. On the other hand if the truss is uncomfortable, and most trusses are, we feel, if the patient is willing to take the slight additional risk which an older person must consider, that he is entitled to the operation even up to the age of seventy-five or eighty. Obviously a truss is contra-indicated in all irreducible hernias.

Operative treatment. The different operative procedures will be dwelt upon in detail under their appropriate headings but there are many general considerations which apply to all and may well be discussed at this time.

General Preparation. A light diet the day preceding the operation, a mild cathartic the night before followed by a low enema the next morning is the usual routine. We feel that the enema is not essential and we occasionally permit cases to enter the hospital on the morning of the operation with only catharsis the night before; and find their post-operative convalescence just as satisfactory.

Patients with large irreducible hernias should be kept in bed several days before operation on a light or liquid diet; and the hernia should be supported to facilitate partial reduction. Oftentimes a decision cannot be reached as to the operability of a given case until this method has been tried to ascertain how much the hernia will reduce and whether it is good surgical judgment to attempt a reduction and cure without increasing the intra-abdominal tension beyond the safety limit.

Local Preparation. On admission a tub bath is given followed by shaving the local area several inches beyond the field of operation. No dressing is applied and nothing further is done until the patient reaches the operating room. The operative field is now painted with a three and one-half per cent. solution of tincture of iodine and allowed to thoroughly dry before draping. If the iodine has been carelessly allowed to run over the scrotum or over the perineum we neutralize it with alcohol. Picric acid, Mercurochrome, Potassium, Mercuric iodide in Acetone and the old fashioned wet bichloride dressings are employed by many surgeons, but the simple iodine preparation has given us such universal satisfaction over a period of twenty years that we have not thought it wise to depart from this routine.

Anesthesia. *General.* The authors feel that general anesthesia is preferable to local in the vast majority of cases. The radical cure of a hernia depends on a satisfactory plastic repair of the posterior wall of the inguinal canal in all cases that are not cured by a simple high ligation of the sac. This we feel can be accomplished much more rapidly and satisfactorily under general anesthesia. Gas and oxygen with a minimum amount of ether or ethylene are the anesthetics of choice. Ethylene in elderly patients, in whom we fear post-operative pulmonary or renal complications, and in patients who have high blood pressure or diabetes, we feel approaches the ideal.

Local anesthesia. The technique of the various local anesthetics will be described in another chapter. We appreciate that many excellent surgeons use local anesthesia in most of their hernial repairs with very satisfactory results. If there is a definite contra-indication to a general anesthesia this method should be employed, but with a skilled anesthetist and a wise selection of the general anesthetic the contra-indications are few. In strangulated cases of long duration and poor general condition local anesthesia is undoubtedly superior.

Spinal. What has been said of local anesthesia also applies to spinal anesthesia. It may be used more in the future but should only be employed by a surgeon who has has considerable experience with the method and can promptly recognize the danger signals and equally promptly combat them.

Sutures. *Absorbable versus non-absorbable.* Most surgeons today use absorbable sutures in all their hernia work. A few still use fine silk and claim with careful technique to avoid sinus formation. Our preference is for kangaroo tendon or chromic catgut.

Living fascial sutures. Since Gallie and Le Mesurier described their method of using living fascial sutures a few years ago, a great advance has been made in the radical cure of hernia. The sutures are taken from the fascia lata of the thigh, each being a quarter of an inch wide and as long as the particular thigh will allow. These are threaded on a special needle and used as ordinary sutures in doing the plastic repair. The details of the technique may be discussed in a general way. The operator having decided upon which side of the patient he will stand, the opposite thigh is prepared at the same time as the hernial field. While the surgeon is getting the hernia ready for the repair the assistant removes the fascia as follows: An incision is made starting at the great trochanter and extending downwards and a little backwards, because the fibers of

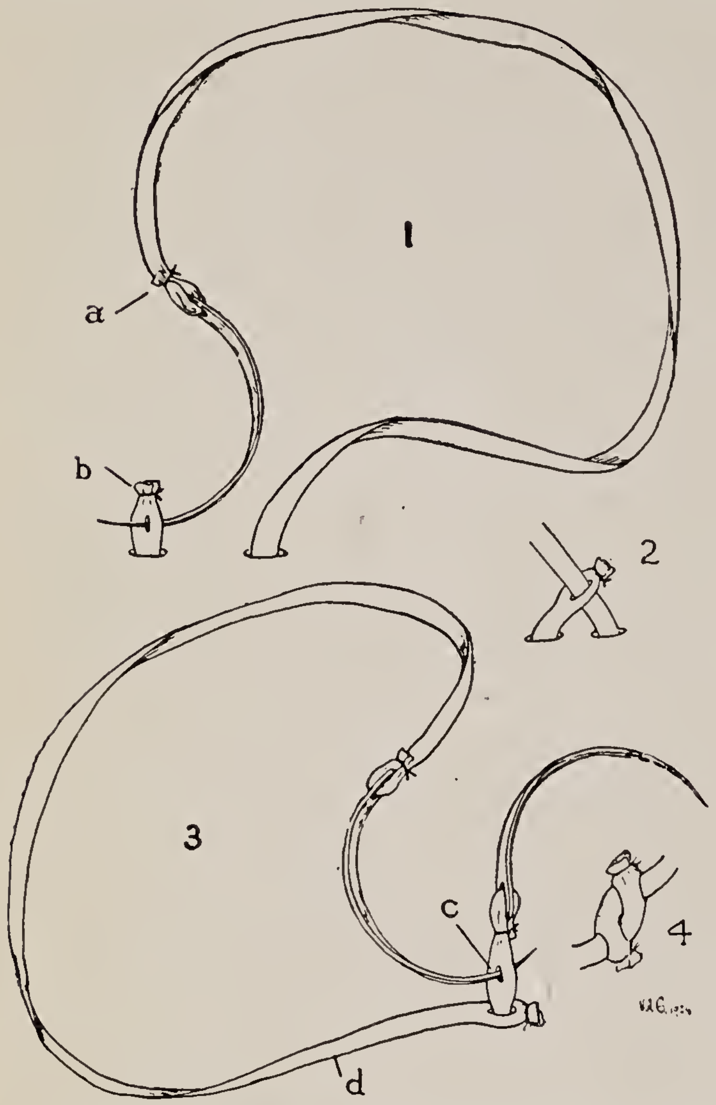

Fig. 1a. Diagrams illustrating points in the technique of using living sutures of fascia. 1, The strip of fascia lata has been tied into a large-eyed needle with fine silk (a), and a similar ligature has been tied around the tail of the suture at b. The needle has been passed through some strong aponeurotic tissue and then through the tail of the suture to form a slip-knot. 2, The slip-knot drawn taut. 3, Method of joining one suture to another. The suture (c) has been used up. The needle of suture c is passed through the tail of suture d, and the needle of suture d is then passed through suture c. The needle of suture c is cut off, and suture d is drawn taut. 4, The joining of the two sutures completed. (Courtesy of Archives of Surgery.)

the fascia lata extend in that direction, to three inches above the knee. The incision having been carried through the skin and subcutaneous tissue to the fascia lata, the former is cleaned away from the fascia and an idea as to the number of sutures required is obtained from the surgeon. As each suture is one quarter of an inch wide, if four are needed a strip one inch wide is obtained, by first making an incision in the fascia one inch long at right angles to its fibers. Two vertical incisions, one-half inch long, are made at either end of the first incision and the angles thus formed are each grasped with Allis forceps. It is now a very simple matter to continue the vertical incisions in the direction of the fascial fibers separating the fascia from the underlying muscle as the incisions are extended until a strip of sufficient length is obtained. Care must be taken not to carry the incisions too far posteriorly else one will get into the external intermuscular septum. It is also important never to start removing the fascia from below upwards because as we reach the insertion of the tensor fasciae femoris into the fascia lata we are apt to be led into the wrong plane and find that muscle is attached to our fascial flap. The strip is now ready to cut into sutures. The four corners are grasped with Allis forceps and two more applied adjacent to the two on the left side. These are all held taut and a strip one quarter of an inch wide is cut, starting between the two clamps on the left near corner with straight scissors. This is placed in salt solution and a second strip cut by applying two more forceps. Each succeeding one is placed in salt solution until they are all cut. The sutures are now threaded and tied in place with plain catgut, the opposite end also being ligated to prevent fraying. Some advocate transfixing to prevent slipping, but it is not essential. The sutures may be left in salt solution, or if they show a tendency to swell may be wrapped in gauze wet in salt solution.

No attempt is made to close the incision in the fascia lata. Gallie recommends it, but in several hundred operations we have seen no disability resulting, in fact we feel it a decided disadvantage to put so much tension on the fascia.

The operator should now have the hernia ready for the plastic repair while the assistant closes the skin of the thigh. The introduction of the sutures will be described in detail in the various types of operation in which we feel fascial sutures are indicated. The following illustrations from Gallie's article illustrate the method of starting, and splicing the sutures.

THE USE OF DEAD FASCIA

Dead Fascia. The use of dead fascia in hernia operations has been the subject of recent work by Koontz of Baltimore who has done animal experiments, which show that when fascia from one animal is transplanted into another, the collagen fibers persist, while the connective tissue cells themselves die. Their places are taken, however, by connective tissue cells from the host, which grow into a network of collagen fibers. Thus, to all intents and purposes, the strength of the fascial suture is not impaired by its coming from a source other than the host.

Koontz has recently reported results on a series of about twenty cases on which ox fascial sutures were used for the repair of hernia. We have ourselves used some of this material, through the courtesy of Koontz, on a very small number of cases.

This work has opened up an interesting field and it may be that further experience will show us that dead fascial sutures will serve our purposes in the repair of hernia as well as the living (taken from the patient himself). At present, however, our preference is decidedly for the living sutures.

Post-Operative Care. Competent nursing will prevent most postoperative complications. Great care must be used to prevent chilling of the patient on the way back from the operating room, and as soon as he is returned to bed, which is preferably a Gatch bed, well warmed with hot water bottles, the knees are supported in slight flexion. This position relieves some of the tension on the sutures. As soon as the patient is entirely out of the anesthetic the head of the bed is slightly elevated, and if pulmonary complications are feared this elevation is materially increased. Frequent turning from side to side also aids in preventing pulmonary congestion. The usual post-operative routine of feeding is followed. Post-operative catheterization is rarely employed. If the patient does not void at the end of twelve hours a hot water bottle is applied over the bladder followed by a low enema which is often successful. At the end of eighteen or twenty-four hours, if the patient is very uncomfortable and all other means have failed the catheter has to be resorted to, but careful asepsis is essential to prevent a subsequent cystitis. In rare instances we may allow the patient to put his feet over the side of the bed and assume almost an erect posture to facilitate the act. Pouring water over the genitals may be effective.

If there is abdominal distention at the end of twenty-four hours a low enema is given. This may or may not be followed by catharsis by mouth. Many so-called gas pains are caused by too vigorous catharsis and we are inclined to give an enema daily for the first week.

The sutures are removed on the seventh day and the length of time in bed varies with the age of the patient and the type of hernia, from ten to eighteen days.

PROGNOSIS AND RESULTS

As we have indicated elsewhere it is exceedingly difficult to state accurately the end results of hernia operations because so many variable factors are concerned. In the first place no statistics are worth serious consideration unless they are based upon cases actually followed for a period of at least a year — better two years after operation. Secondly, the results should be classified according to the type of hernia and age of the patient. An example of the importance of this is the futility of grouping together cases of indirect and direct hernia, or of primary and recurrent hernia in adults and children. The expectation of cure by operation varies so markedly in these groups that mass statistics of results are of little value. These two variable factors (length of follow up and grouping according to age and type of hernia) are the most important, but many of lesser importance might be mentioned. (See Recurrent Inguinal Hernia.) When one comes to umbilical and ventral hernias the size of the hernia and of the neck of the sac and the degree of incarceration or irreducibility render each case so much a law unto itself that statistics are apt to be most misleading.

We feel that, speaking of followed cases only, with average or better than average surgical skill the results in indirect inguinal hernia in children under 14 should range between 98 and 99% of successes; in adults with indirect inguinal hernia (excluding sliding hernia) 85 to 95%; adults with direct hernia, or saddlebag hernia 75 to 85%; with recurrent inguinal hernia 50 to 75%, depending upon the type of operation performed and ranging from a simple Bassini to a living suture technique.

Femoral hernia is probably curable in 90 per cent. of cases if strangulated hernias are excluded. Here, as in strangulated hernias of other types, the operation is a life saving measure designed to relieve intestinal obstruction as rapidly and as safely as possible and the repair is a secondary consideration.

Umbilical hernia in children and small ones in adults should give at least 90% successful results — the large hernias in obese adult females give results too variable to make evaluation worthwhile; we believe fascial suture will give the best results in this group.

The same may be said of ventral hernias and of the other rarer forms of hernia. In general, however, one should urge operation as early as possible in both ventral and umbilical hernias for the reason that the contents tend to become adherent to the sac early, and strangulation may easily supervene, and because the increase in the size of the sac neck is an important factor in rendering the individual case less favorable for permanent operative cure.

INGUINAL HERNIA

Etiology. The causes of inguinal hernia may be considered under two headings: those that are predisposing, and those that are exciting or direct causes. Predisposing causes: 1. age; 2. sex; 3. heredity; 4. anatomical considerations (e. g. descent of processus vaginalis); 5. adiposity.

PREDISPOSING CAUSES

Age. Inguinal hernia is undoubtedly most common at the extremes of life. In infancy and childhood the defects due to mal position of the testicle and failure of obliteration of the tunica vaginalis are promptly manifested by the development of hernia.

With advancing years atrophy of the muscles of the abdominal wall and degeneration of the tissues, which come with age, are responsible for the development of many of the cases of direct inguinal hernia which are commonly seen in men over forty.

Sex. The factor that sex plays in the incidence of inguinal hernia is apparent from the following figures. Of 9188 consecutive inguinal hernias operated upon at the Ruptured and Crippled Hospital, 7943 were in males and 1245 were in females.

This marked difference in the sexes has been attributed to the greater frequency of failure of the processus vaginalis to become completely obliterated in the male, and to the larger opening necessary for the passage of the spermatic cord.

There has never seemed to be a satisfactory explanation for the extreme rarity of direct inguinal hernia in the female.

Heredity. The tendency for inguinal hernia to appear in successive generations of a family has long been recognized. Whether it can be explained upon the inheritance of a weak abdominal musculature or tendency to congenital defects is doubtful. The question is too theoretical to deserve extended consideration.

Anatomical Considerations. Certain anatomical defects in the muscle and aponeurotic layers of the inguinal region undoubtedly are of great importance in the formation of the inguinal hernia; these have already been described in sufficient detail in the section dealing with the anatomy.

Adiposity. Fat, suddenly acquired or in marked excess, plays a most important part in the production of inguinal hernia, and acts in a variety of ways. It increases intra-abdominal pressure; it forms subperitoneal lipomata which, under conditions of abnormal or oft repeated strain, may protrude through the internal ring and act as the entering wedge to be followed by a process of peritoneum foredestined to become a true hernial sac; moreover it infiltrates aponeurotic and muscular structures which makes the subject more unfavorable for operative cure. It is in this type of male that direct hernia is often seen.

Direct or Exciting Causes. Immediate or direct causes of inguinal hernia may be considered collectively as those which are associated with a sudden extreme increase in intra-abdominal pressure, or a succession of oft repeated less violent strains. While these factors are too numerous and varied to permit of enumeration, some of the more common are lifting or carrying of heavy weights; falling while carrying a burden; muscular strain, such as gymnastics, trials of strength, etc; coughing, as in whooping cough or chronic bronchitis; obstructions to urination; constipation, with straining at stool. Frequently an adult who has never noticed any weakness in the inguinal region will ascribe the onset of an inguinal hernia to a severe strain (accompanied by a violent contraction of the abdominal muscles). Hutchinson analyzed 243 cases of inguinal hernia coming on in adult life and found that in 68% the onset was attributed to a violent effort or an injury such as may happen to any man engaged in hard manual work. The importance of ascertaining the exact part played by occupation in these cases is great, since with the advent of workmen's compensation laws in many of our states and in other countries the question of responsibility is constantly being raised.

There are two divergent views of the question: one group of students of this subject holds that, as Russell of Australia has maintained, the indirect inguinal hernias are all of congenital origin. They explain these so-called occupational hernias (French hernia of effort) as hernias into preformed sacs, the existence of which has been noted by the subject in association with a previous strain or injury. They reserve the term " traumatic hernia " for the exceptionally rare case where there has been actual violence directly over the inguinal region with rupture of muscle and aponeurotic structures. Quoting from the report on " Traumatic and Industrial Hernia,"[1] — " the main point that cannot be emphasized too strongly is that hernia is never the result of a single strain or a single increase in intra-abdominal pressure due to any of the causes mentioned. On the other hand it is the cumulative effect of a great number of strains spread over a considerable period of time. In nearly all instances, hernia is of gradual onset, is rarely accompanied by pain and most frequently remains unnoticed until it has reached a considerable size, or until some accident or strain, by slightly increasing the contents of the hernia sac causes it to be noticed for the first time.

The other group of authorities maintain that, while many indirect inguinal hernias are obviously of congenital origin and that their associations with occupation is co-incidental rather than that of cause and effect, still there is a considerable percentage in which without any previous evidence of inguinal hernia the onset of an indirect hernia is associated with a sudden marked increase of intra-abdominal pressure. In these cases the indirect sac is often found at operation to be much less closely associated with the cord structures and less intimately bound to them by the infundibuliform layer fascia as is the case in those that are obviously of congenital origin.

We feel that in these cases the most important element in the strain lies in its suddenness — its catching the subject " off his guard " when his muscles are not contracting co-ordinately. We have noted this feature so frequently in obtaining the history of the alleged strain that we feel considerable importance should be attached to it. Moreover, the individual who is habitually performing heavy manual labor is less apt to develop this type of hernia, even when the lifting of very heavy loads is involved, than is the man who suddenly attempts to lift or push some heavy object which, in his ordinary occupation, he is not called upon to do.

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[1] Report of the Special Committee of the Med. Section, American Railway Ass'n — Annals of Surgery, April, 1922, p. 467.

ANATOMY OF INGUINAL HERNIA

The anatomy of inguinal hernia may best be studied by considering its production when, (*a*) as a direct result of some developmental defect, it is present at or soon after birth; (*b*) the hernial sac being present congenitally, the hernia follows some increase of intra-abdominal pressure; or (*c*) as a consequence of a less marked or less complete defect present, however, since birth, the hernia develops in the presence of causative factors. (Figure 1.)

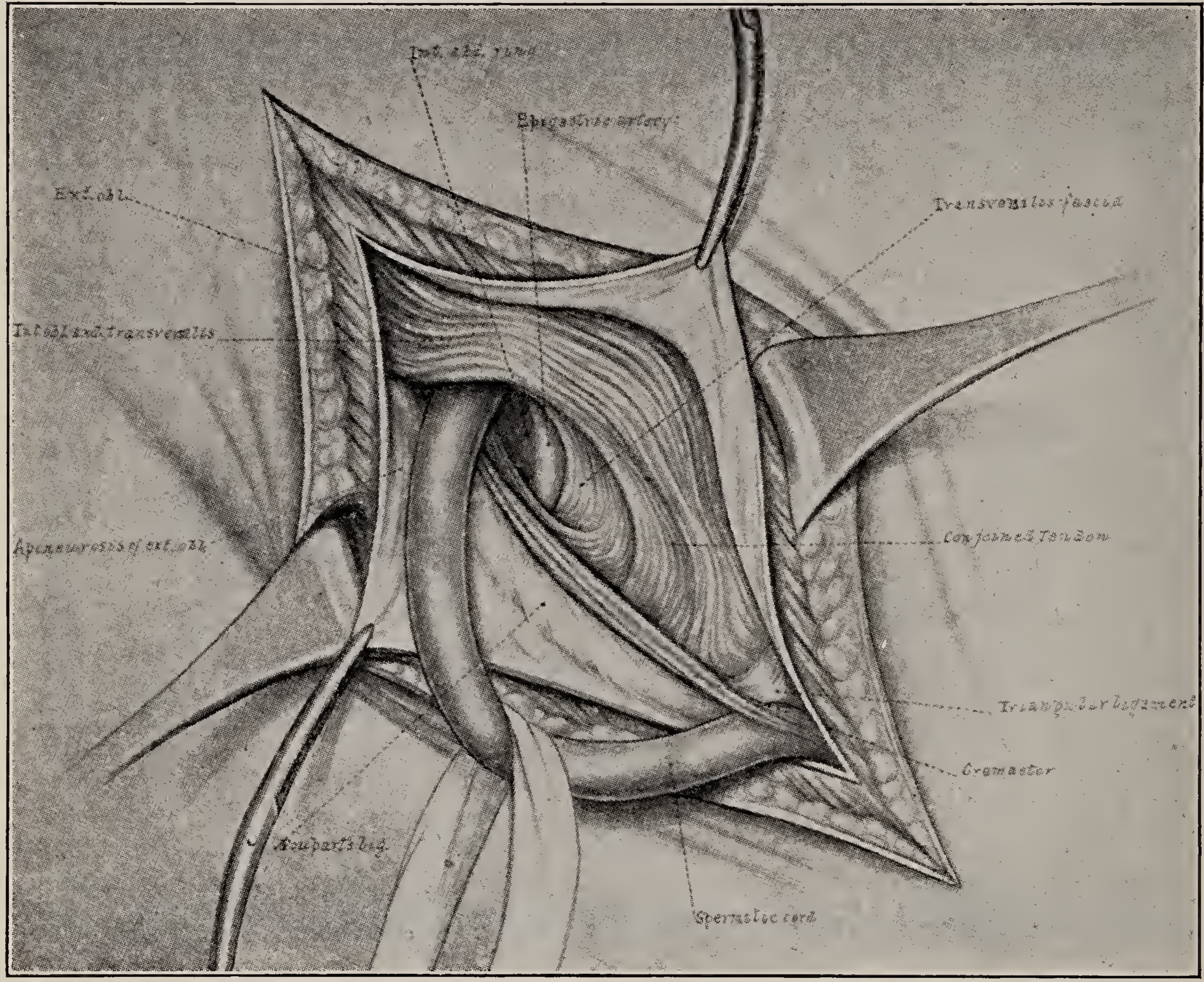

Fig. 1. Anatomy of inguinal region. (Courtesy of Archives of Surgery.)

Knowledge of the changes in the abdominal wall and peritoneum involved in the descent of the testis is essential to a proper understanding of the anatomy of inguinal hernia. The testis migrates during the later part of intra-uterine life to a position which later corresponds to the internal abdominal ring. As it passes through the internal ring, it receives its first investment from the transversalis fascia — this is called the infundibuliform layer. Next it acquires a covering from the internal oblique, known as the cremasteric fascia. This layer contains discrete muscle fibers as well, called the cremasteric muscle. Continuing its course, the testis next receives a layer from the external oblique as it emerges from the external abdominal ring — the intercolumnar fascia. These layers are consequently found as coverings of the indirect inguinal hernial sac, since such a sac is merely a result of a failure of fusion of the processus vaginalis, as the peritoneal pouch is called, which the testis carries after it in its descent. This pouch fuses normally from a point on a level with the internal ring down to the level of the testis, where it persists as the tunica vaginalis testis, or sac in which the testis lies.

Should fusion of the processus vaginalis fail to take place, conditions are then ideal for the subsequent development of a hernia of the oblique or indirect type. The hernia may exist as such at birth, or be noticed shortly thereafter; may develop later as a result of some increase in intra-abdominal pressure; or, if the defect in fusion be even less marked, it may require for its manifestation well marked causative factors, such as repeated strains. Should fusion be complete at the internal ring but fail to take place at any level below this point down to a point near the testis, the result will be the formation of a " hydrocele of the cord "; the analagous condition in the female is known as a " hydrocele of the canal of Nuck." It may happen that the point of fusion is not precisely at the internal ring, but slightly below it. Under such circumstances it is obvious that a hydrocele of the cord or of the canal and an oblique hernia may coexist. A hernial sac should, therefore, always be searched for when an operation is performed for a hydrocele of the cord or of the canal of Nuck.

Many anatomical texts describe a variety of types of indirect or oblique hernial sacs. For our purposes, however, suffice it to remember that where total failure of fusion has taken place, the sac is continuous with the tunica vaginalis testis and contents of the sac are, therefore, in direct contact with the testis; this variety we have called the congenital type (Macready). All other indirect sacs may be termed " acquired " in type, though this term is not apt, as it fails to connote developmental etiology.

As Eccles has pointed out, the term congenital when applied to hernia, relates to the condition of the parts that predispose to hernia and not to the question of the existence of the hernia at birth. With this in mind it is clear that the majority of indirect hernias are due to developmental defects. An individual may carry a patent funicular process through life without developing a hernia.

RELATION OF THE OBLIQUE SAC TO NEIGHBORING STRUCTURES

The sac in an oblique inguinal hernia lies anterior to the spermatic cord, though often spread out upon it so as to almost surround it, save on its posterior aspect. The infundibuliform fascia, a thin areolar layer, invests both sac and cord, causing them to be closely adherent to one another. Fatty masses often are included in this infundibuliform layer. The sac may extend only partly along the inguinal canal, when it is termed an *incomplete hernia*, or *bubonocele*. Should it escape from the external ring, it becomes a *complete hernia* and further progress brings it into the scrotum where it may be termed a *scrotal hernia*. The presence of the deep epigastric artery at the inner border of the neck of the sac is the most reliable criterion by which to definitely distinguish a small indirect sac from a direct one. The larger indirect sacs have no close resemblance to direct sacs and confusion is not likely to occur.

Contents of the sac. It seems beyond doubt that in most oblique hernias the omentum first enters the sac. Adhesions between omentum and sac wall are readily formed. Subsequently, when the orifice has become sufficiently dilated to accommodate it, intestine follows. Small intestine is by far the most common finding exclusive of omentum. Both are often found together. Adhesions are less likely to form between intestinal coils and sac wall. The larger scrotal hernias may contain, on the right side cecum, on the left, sigmoid colon. (See Sliding Hernia.) The inclusion of only a portion of the circumference of the bowel wall in the sac is a condition known as partial *enterocele* or *Richter's hernia*. A hernia containing a Meckel's diverticulum has been termed a Littre's hernia.

The indirect sac varies in its character, from the most delicate, thin, veil-like membrane of early childhood, or in some cases even in adult life, to a thick, sclerotic, toughened, fibrous layer, such as is seen in large, long-standing scrotal hernias in adults. The use of a truss is said to produce thickening of the sac. The sac may be the seat of peritoneal tuberculosis; it may be filled with metastatic carcinoma; or it may become perforated from pressure of contained strangulated intestine.

Nerve supply of inguinal region. The innervation of the inguinal region and spermatic cord is from the eleventh and twelfth dorsal and first three lumbar nerves. Running between the internal oblique and transversalis muscles, the eleventh and twelfth dorsal nerves give off muscular branches to supply these muscles and sensory fibers to the skin. From the upper cord of the lumbar plexus, the hypogastric branch of the ilio hypogastric and the inguinal branch of the ilio inguinal nerves run downward to a point opposite the anterior superior iliac spine, the former coursing between internal oblique and transversalis muscle, the latter subperitoneally. At this point, the ilio-inguinal perforates the transversalis muscle. At the level of the internal ring both nerves lie between the aponeurosis of the external oblique and the internal oblique muscle close to the cord, superficial to it, and readily visible during operation.

The surgical importance of these nerves has been the subject of much controversy. Dowd and Moschowitz report conflicting results on experiments dealing with this subject. Recently Edmund Andrews clearly demonstrated by means of electrical stimulation of both segments of the divided nerve in the human, that the ilio hypogastric nerve is motor to the lowest fibers in the internal oblique muscle and that all the motor fibers are given off before the nerve enters the operative field. Hence, accidental section of this nerve will not cause any paralysis of this muscle. Accidental division of these nerves during herniotomy can be avoided with care and their inclusion in repair sutures should be guarded against. Neuritic pains of the scrotum, inguinal region and upper part of the thigh sometimes persist in cases where this nerve has been caught by sutures or otherwise roughly handled.

The genital branch of the genito-crural nerve enters the inguinal canal on the posteromedial aspect of the cord and accompanies it as it emerges from the external ring. Its chief function is to supply motor fibers to the cremaster muscle.

The spermatic cord. The spermatic cord is a term used to include the structures leading to and from the testicle. Its elements are: the vas deferens, or efferent duct of the secretory system of the testis, the spermatic artery, the pampiniform plexus of veins that drain this organ, and a tiny artery which accompanies the vas, the artery of the vas deferens. The genital branch of the genito crural nerve and branches from the spermatic sympathetic plexus are also components of the cord. Its covering is a thin, areolar fascia, the infundibuliform layer, which surrounds the cord elements and attaches them to each other. Muscle fibers, the so-called cremaster muscle, are looped down over the cord and attached to it by this layer of fascia. The vas, curving up from below and passing around the deep epigastric artery, meets the vessels which run downward at the internal ring. Having joined at this point they pass along the canal and over the pubic crest to gain access to the scrotum, where they terminate at the testis. When an indirect sac is present, it is invested by the infundibuliform fascial envelope and hence lies in close relationship to the cord elements. Its position is usually anterior and slightly internal to the cord itself, though with increase in the size of the sac this relationship is not always constant. It is obvious that to separate sac from cord the envelope of infundibuliform fascia must be opened.

The round ligament is the structure in the female analogous to the spermatic cord in the male. It extends from the upper anterior portion of the fundus of the uterus, forward to traverse the abdominal wall, entering the internal inguinal ring where it passes along the canal, emerging at the external ring to be lost in the subcutaneous fatty tissue of the labium majus. In its course along the canal, it has the same relationships as the spermatic cord in the male. The peritoneal process called the canal of Nuck enters the inguinal canal in the female fetus just as does the processus vaginalis in the male and, while ordinarily obliterated at birth, it may persist, producing similar complications and conditions as in the male. If it persists throughout, a congenital inguinal hernia is the result. If obliterated at the inguinal ring, an encysted hydrocele of the canal may be found. Hydrocele of the canal of Nuck is a tense, fluctuating tumor, which by manipulation cannot be forced from its position in the inguinal canal. If unusually enlarged, transillumination may show it to be translucent.

DIRECT INGUINAL HERNIA

A proper appreciation of the anatomy of direct inguinal hernia is essential to an understanding of it as a distinctly different problem from that of the indirect variety; the latter we have shown is almost invariably the result of developmental defect. Direct hernia, on the other hand, is due to a deficiency in the musculo aponeurotic structures which make up the inner portion of the posterior wall of the inguinal canal. The extreme rarity of the condition in women and children and its comparative infrequency in young adults is well known — the curve of its incidence is low where that of indirect inguinal hernia is highest, and reaches its height where the latter is low.

Direct hernia is a disease of muscular atrophy, atony of disuse, fatty degeneration of muscle and stretching of aponeurotic and fascial structures. (Figure 2.)

To consider its anatomy in some detail let us refer to the inner aspect of the lower part of the abdominal cavity. The urachus marks this region off into a right and left side. Each side is further divided into two shallow depressions by a slight elevation which is raised by the peritoneal fold over the deep epigastric artery. The outer depression is known as the external inguinal fossa and it is in this region that the internal abdominal ring is situated, through which the indirect hernia protrudes. The inner depression is further subdivided by the fold of peritoneum over the obliterated hypogastric artery into two other fossae, the more medial of which is termed the supravesical, the more lateral being called the internal inguinal fossa. This space contains the triangle of Hesselbach, bounded by deep epigastric artery, Poupart's ligament and the outer edge of the rectus. The external ring is situated just in front of the lowest portion of Hesselbach's triangle. It is this structure therefore that, in the normal individual, the examiner's finger in the external ring meets when palpating directly backward. The portions of the internal

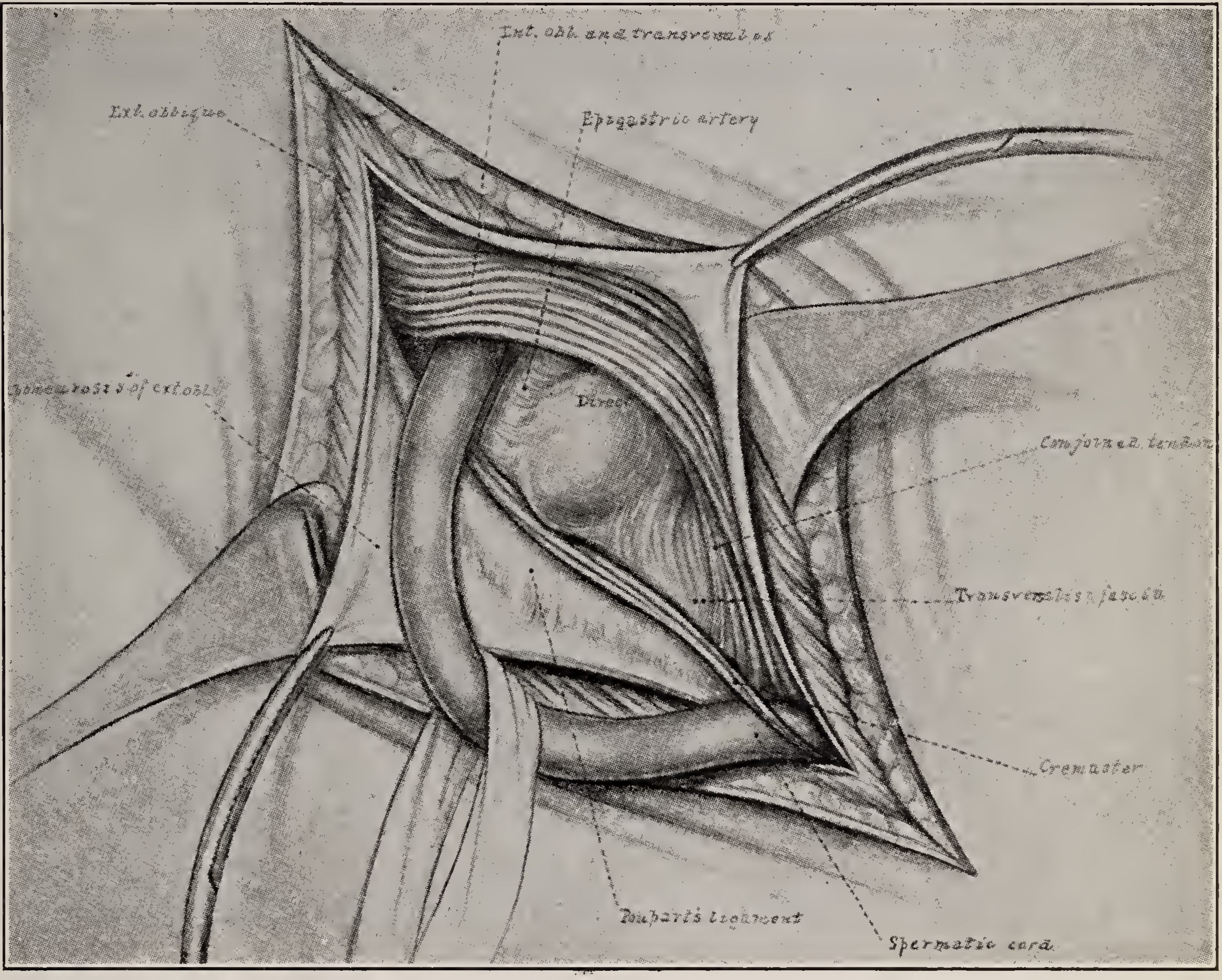

Fig. 2. Direct inguinal hernia. (Courtesy of Archives of Surgery.)

oblique and transversalis muscles which arise from the outer half and outer third of Poupart's ligament blend into a common aponeurosis, extend toward the edge of the rectus and become part of the anterior sheath of the lower fourth of this muscle and continue down to be inserted in the pubic crest and pectineal line. This blending of the aponeurotic portions of these two muscles is termed the conjoined tendon. This tendon extends laterally from the edge of the rectus muscle and lies just behind the external ring and anterior to the transversalis fascia. When well developed both in thickness and in breadth, this structure is of the utmost value in preventing the onset of direct hernia. However, in the very subjects in which this type of hernia is most often found, the conjoined tendon is markedly deficient or even absent at this level. The transversalis fascia lies deep to the conjoined tendon and may be said to form the floor of this triangular area. The inner portion of this fascial area contains fibers which run from the upper surface of the pubis to the rectus; laterally, similar fibers surround the inner border of the internal ring and fuse with the medial surface of Poupart's ligament. Beneath these two portions lies the thinnest part of the fascia and the weakest part of the floor of the inguinal canal. When these two sets of aponeurotic fibers are broad and well developed, the weak spot is narrow, but when poorly developed and atrophic, the weak spot is wide; and it is through this point that the great majority of direct hernias occur.

The direct sac is characterized by its short length and broad neck, the opening being relatively much larger in proportion to the length of the sac than in the average indirect hernia. Since there is no pre-existing path along which direct hernia progresses, it remains globular in shape and on reduction or, in the supine position, falls directly backward into the abdomen. This type of hernia rarely descends into the scrotum.

We feel the occurrence of direct hernia is due to the defective quality of the transversalis fascia more than to any other single factor. This fascia seems thin and of doubtful value as a restraining layer when it is dealt with at operation. It bears the same etiological relationship to direct hernia as the presence or absence of a patent funicular process does in the indirect type. If the transversalis fascia holds, there will be no direct hernia. If it gives way diffusely, as it usually does, the conjoined tendon will be pushed medially (if present at this level) and the bulge present as a direct hernia.

SYMPTOMS AND DIAGNOSIS OF INGUINAL HERNIA

Reducible — Subjective. The patient or, in a child, the parents, frequently make the diagnosis by giving the history of a swelling appearing in the groin on standing or on exertion — which disappears on lying down. Pain is variable; usually there is a sense of discomfort or weakness on the side affected, but in an easily reducible hernia severe pain is rarely a symptom and it has been our experience that patients complaining of pain either in the groin or testicle rarely show evidence of a hernia.

Objective. *Inspection.* If the hernia is of sufficient size to appear outside the external ring or descend into the scrotum and disappear on lying down the diagnosis is obvious on inspection.

Palpation. Here again a large reducible hernia is perfectly simple to diagnose. The difficulty lies in diagnosing a small sac which extends into the inguinal canal for a short distance, or, if it does pass through the external ring, is not large enough to be visible on inspection. In these cases we must rely for diagnosis on an impulse on coughing. Palpation to elicit an impulse should be performed as follows: Place the palmar surface of the index and middle fingers over the internal ring and canal parallel to its long axis; have the patient cough repeatedly and as he coughs press the fingers back and forth. This allows the small sac to alternately distend and collapse, and as it does, a sensation similar to the crackle felt in a subcutaneous emphysema will be imparted to the examining fingers. This method, in our opinion, is the only way to elicit a true impulse. We cannot condemn too strongly the usual practice of attempting to obtain an impulse by passing one or more fingers through the external ring. The bulge which comes down against the fingers on coughing is, in no sense, an impulse and is obtained just as easily if no hernia existed.

In examining a patient for suspected hernia particularly in children always palpate the scrotum first and assure oneself that both testicles are normally descended. It will save many an embarrassing situation. Also there may be a sac extending into the scrotum which contains a slight amount of fluid, but with a neck too narrow to give an impulse. Careful palpation of the scrotum will demonstrate the probability of fluid and on coughing the increased intra-abdominal tension will be transmitted through the canal to the fluid in the lower part of the sac.

Irreducible. As the name implies, a hernia exists which does not disappear on lying down and the contents of the sac cannot be returned to the abdominal cavity by manipulation. An impulse may or may not be obtained. Frequently the sac may contain both intestines and omentum, the former being reducible emitting a definite gurgle as they slip back through the internal ring, while the omentum due either to the disproportion between it and the internal ring or to its adherence to the sac cannot be reduced.

Incarcerated and Strangulated. The history of the sudden onset of an irreducible tumor with severe pain followed by nausea and vomiting is pathognomonic. On palpation a tender irreducible mass is found which does not give an impulse on coughing. The hernial orifices should be carefully examined in all cases of suspected intestinal obstruction.

Differential Diagnosis. Indirect vs. Direct Hernia.

Inspection. A hernia that descends into the scrotum is practically always indirect. The indirect sac follows the inguinal canal and can usually be seen to distend it from the internal to the external ring. The direct sac appears directly behind the external ring. The indirect hernia is pear shaped and the direct spherical.

Palpation. Passing one's finger through the external ring in a direct hernia the opening in the posterior wall of the canal can be felt directly over the crest of the pubis with usually a weakness of the entire posterior wall, while in an indirect sac the posterior wall is firm and well developed. We frequently see a well marked indirect sac with a definite direct weakness, and a conscientious effort should be made to diagnose this condition as it has a marked influence on the type of the operation indicated for the radical repair.

Inguinal Hernia vs. Femoral Hernia. The cardinal diagnostic point is the relation of the hernia to the spine of the pubis. An inguinal hernia is always internal and when small is above the spine. The neck of the femoral sac is always external and below the spine. The fundus of the sac may lie above Poupart's ligament on the aponeurosis of the external oblique and lie external but above the spine.

Inguinal Hernia vs. Varicocele. A soft elastic mass feeling like a bunch of angle worms in the upper part of the scrotum, no impulse on coughing, disappearing when the patient lies down but reappearing from below upwards when he stands are the diagnostic points in favor of a varicocele. Occasionally a mass of dilated veins in the canal will give one the impression of an impulse and in these cases the differential diagnosis may be impossible.

Inguinal vs. Hydrocele of Tunica Vaginalis. An irreducible cystic tumor in the scrotum which transmits light with an area of normal scrotum above between the tumor and the external ring usually makes the diagnosis simple. It is important to bear in mind the possibility of a thin strip of omentum passing down through a narrow hernial sac into the scrotum with an accumulation of fluid about its lower end. This condition resembles very closely a simple hydrocele and differentiation may be very difficult.

Hydrocele of the Cord or Canal of Nuck. This condition is an encysted accumulation of fluid in a hernial sac. It occurs chiefly in children and occasionally in women. The presence of a painless movable elastic swelling in the canal or just outside the external ring is strongly suggestive of this condition. In children, hydrocele of the cord may resemble a strangulated hernia so closely that it cannot be differentiated by physical examination only. A careful history revealing a sudden onset with pain and absence of bowel movements for some time will point to the diagnosis of strangulated hernia; nausea and vomiting will make the diagnosis certain.

Undescended Testicle. The absence of the testicle in the scrotum and the presence of a firm tumor possessing testicular sensation either in the canal or just outside the external ring usually make the differentiation positive. The undescended testicle may or may not be accompanied by a recognizable hernia.

TREATMENT OF INGUINAL HERNIA

Both the mechanical and operative treatment of inguinal hernia are entirely different problems in children and adults and consequently will be considered separately.

Children — Mechanical Treatment. For many years at the Hospital for Ruptured and Crippled we have believed that mechanical treatment has been effectual in curing a fair proportion of hernias in children under four years of age. A certain number of these so-called cures return later with a definite hernia so that it is impossible to state how satisfactory the end results are, but we are convinced they are under 50 per cent. Over four years of age mechanical treatment is less satisfactory and we advise operation unless there is some definite contra-indication.

Doctor W. B. Coley in 1905 made several exceptions to the mechanical treatment in young children which we feel still hold true:

(1) If there is a history of strangulation that has been reduced by taxis an operation is indicated no matter how young the child.

(2) In cases in which, despite carefully directed truss treatment, the hernia has become irreducible or reducible with difficulty early operation should be advised.

(3) In cases in which the rupture cannot be controlled by a truss and as a consequence is gradually increasing in size.

(4) In cases associated with reducible hydrocele or fluid in the hernial sac as it is impossible to control the rupture and hence nothing is gained by waiting.

Method of Mechanical Treatment. A yarn truss is indicated in very young babies especially if undernourished. If properly applied with the loop held directly over the internal ring and definite support given along the inguinal canal many ruptures are satisfactorily retained by this method until the baby is old enough to wear a truss without irritation. The disadvantages are that the yarn must be changed whenever it becomes soiled and consequently the procedure is tedious and expensive.

Any truss that is comfortable and retains the hernia is satisfactory. For many years we have used the Knight cross body truss at the Ruptured and Crippled Hospital with great satisfaction. It consists of a light steel frame extending three quarters around the pelvis, the remaining distance being covered with an adjustable strap. The spring is covered with rubber tubing and the pad is attached to a short steel arm fastened at right angles to one end of the spring. The truss is applied, after reduction of the rupture, with the baby in the recumbent position, the pad being placed directly over the internal ring. It is well to place a double layer of canton flannel beneath the pad and also beneath the opposite end which should lie over the posterior superior spine of the ilium. It is very important to have the patient return within two days to be sure no undue pressure has been exerted and that the truss has not slipped. It should be worn constantly.

A frame truss such as the Pomeroy or a French truss with a perineal strap is equally valuable but also more expensive, and the truss has to be changed frequently as the child grows.

Operative Treatment. High ligation of the sac undoubtedly cures the vast majority of indirect inguinal hernias in children. Transplantation of the cord adds very little to the length of the operation and we believe it should be adopted as routine with the possible exception of children under two years and cases of strangulation, when the time element is of the greatest importance.

Technique of the Bassini Operation. The towels are draped so that the minimum amount of skin is exposed and the towel clip which fixes the drapings below the inferior angle of the proposed incision includes the skin, which prevents their slipping and eliminates possible contamination of the wound from the skin which may not have been sufficiently sterilized.

Incision. The bony landmarks which should always be palpated are the anterior superior spine of the ilium and the spine of the pubis which gives one the direction of Poupart's ligament. The incision begins over the internal ring which lies one half inch above the middle of Poupart's ligament and terminates just above the spine of the pubis over the external ring. Consequently the incision does not lie one half inch above and parallel to Poupart's ligament but is a little vertical to it and follows more closely the fibers of the external oblique aponeurosis. The incision is carried through the fascia to the aponeurosis and the external ring identified. If the ring is not readily exposed, which frequently occurs in children, retract the lower angle of the wound downwards and inwards and palpating the pubic spine the ring will be found above and internal

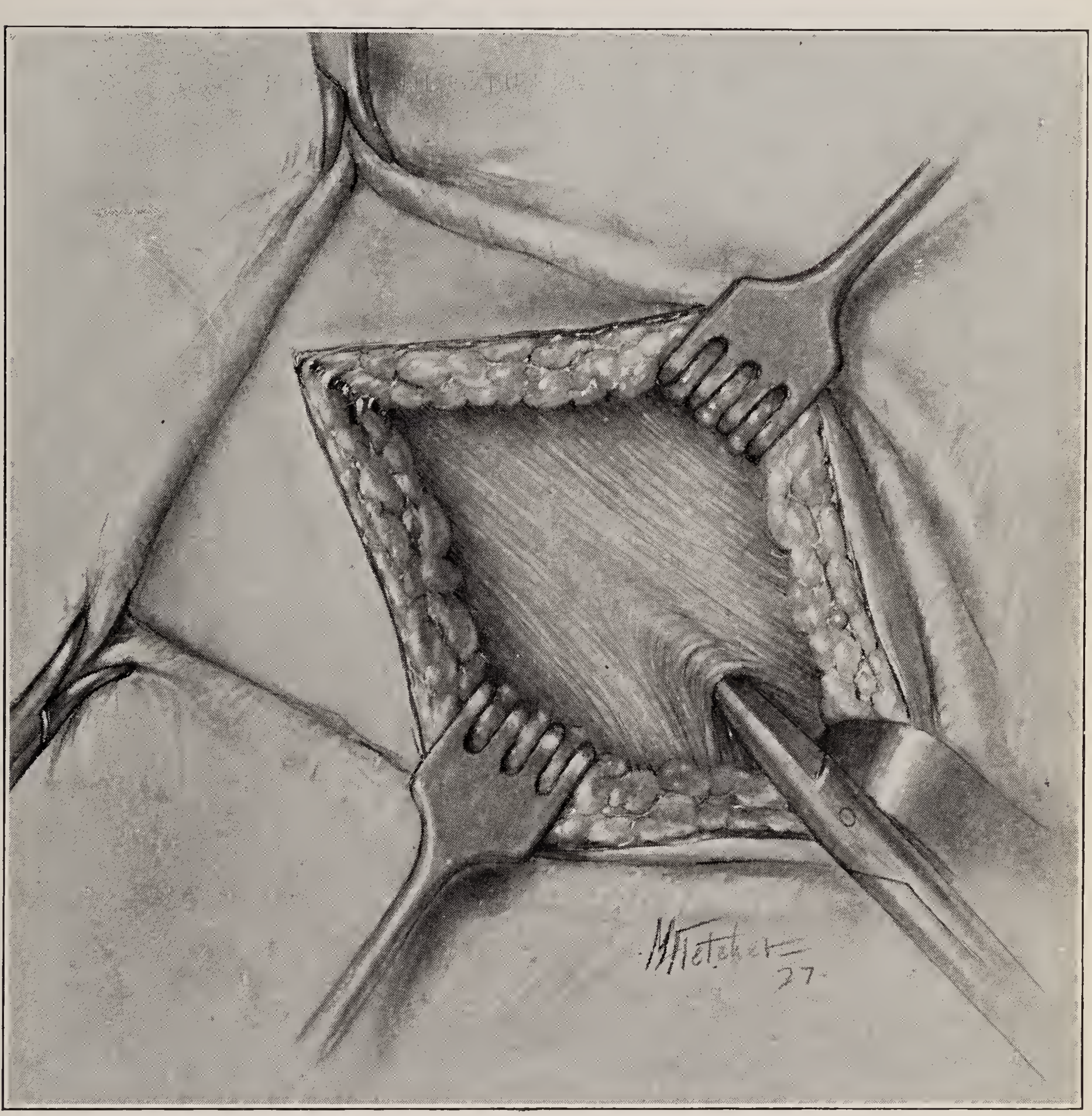

Fig. 3. Exposure of external ring.

to this bony landmark. The aponeurosis is divided from below upwards by inserting one blade of the scissors or a grooved director. (Figure 3.) It is important to incise a little at a time and withdraw and re-insert the instrument to avoid dividing the ileo inguinal nerve. If one prefers, the incision may be started above at a point opposite the internal ring and continued down to the external ring, but the same precautions must be observed not to injure the nerve. The upper and lower leaves of the aponeurosis are retracted, exposing Poupart's ligament and the inguinal canal. Grasp the cremaster with tooth forceps near the internal ring, dividing it in the direction of its fibers. (Figure 4.) By keeping the fibers separated with the scissors in situ the glistening sac and cord are

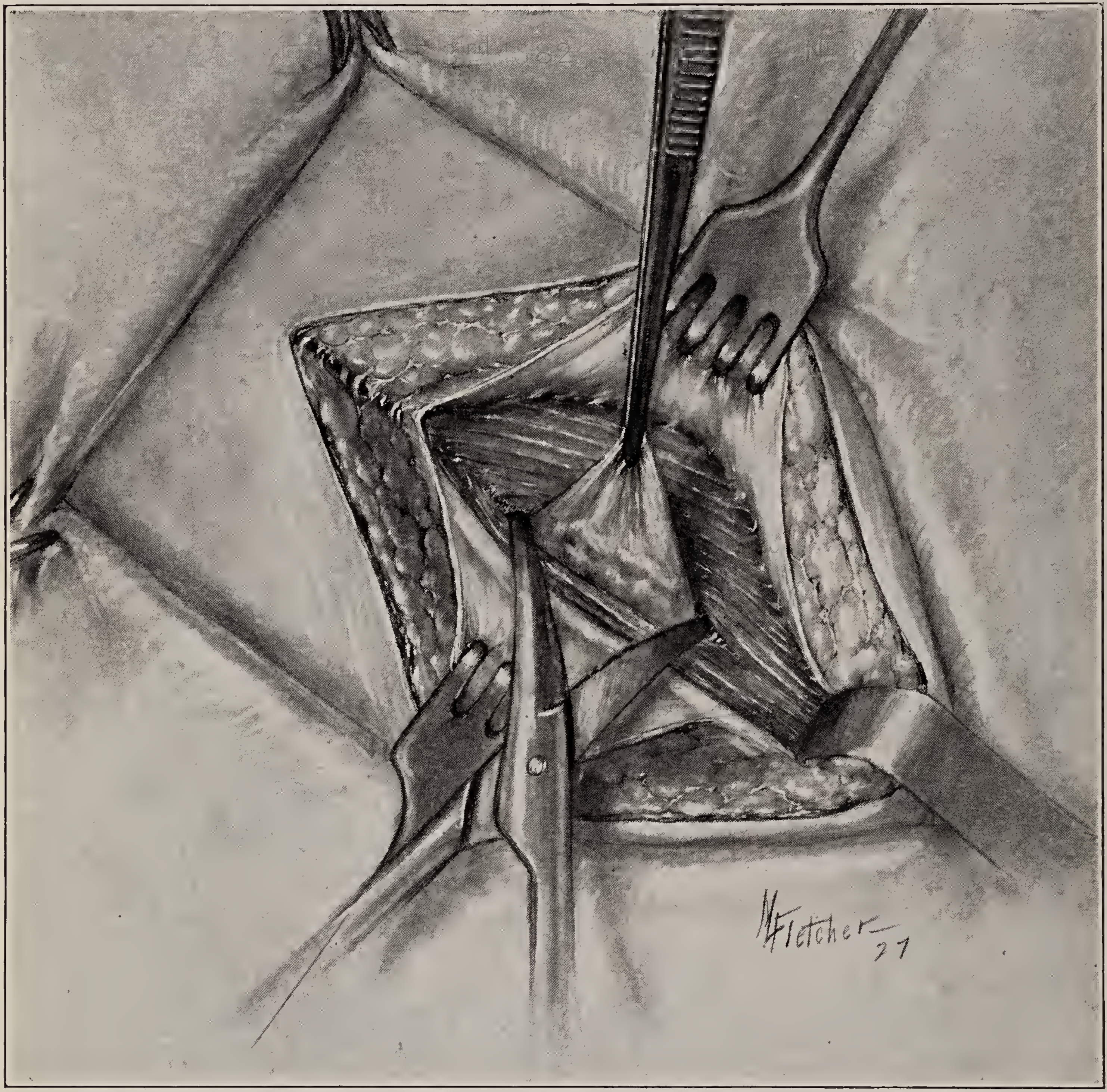

Fig. 4. Delivery of Sac and Cord from bed of cremaster.

seen in the bottom of the incision and easily delivered. They are bound together by the infundibuliform prolongation of the fascia lata. Insert the index finger of the left hand beneath them and tear through the fascial layer with forceps or a thin layer of gauze, placing an artery clamp on the exposed sac. (Figure 5.) The cord structures are spread

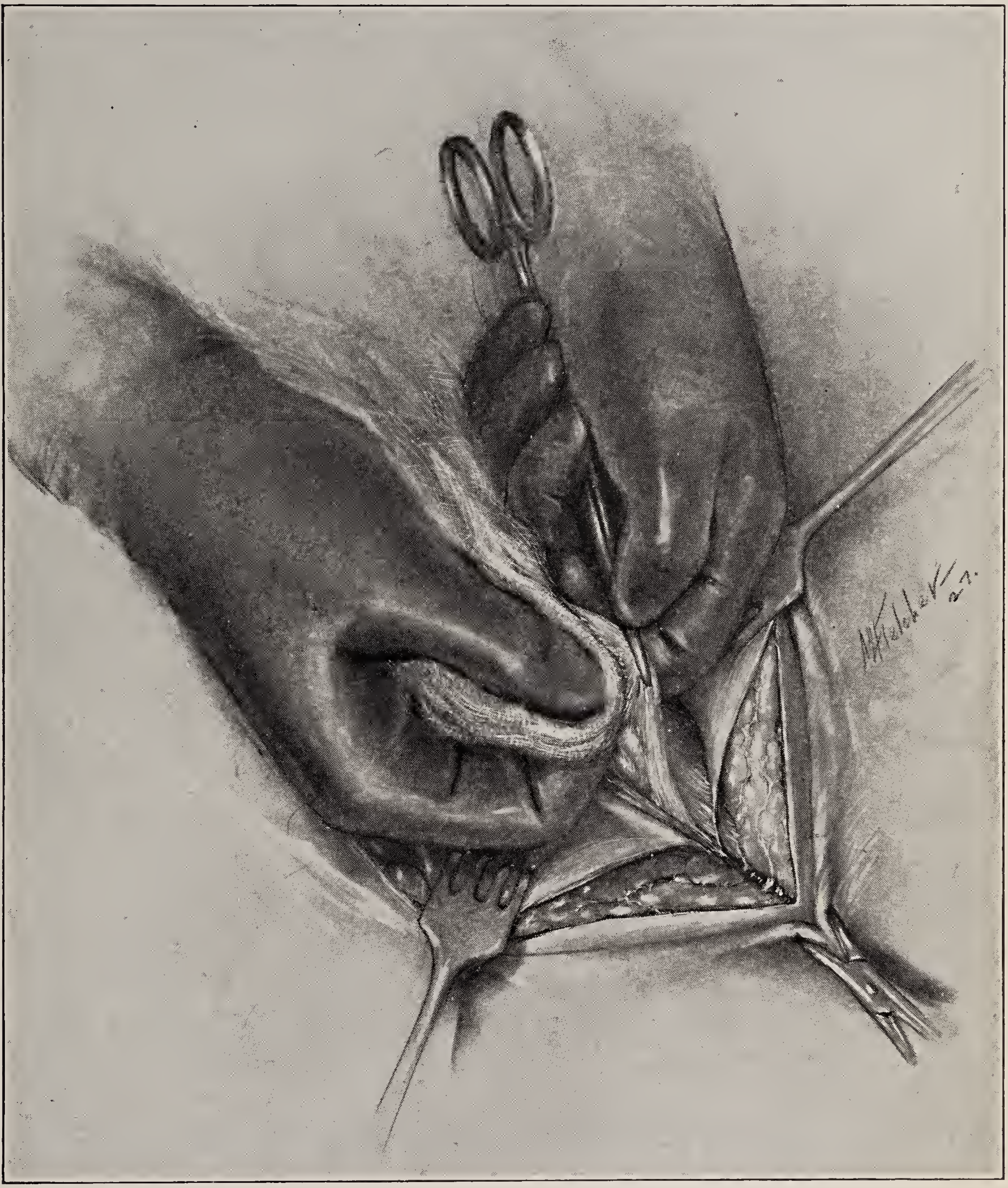

Fig. 5. Separating sac from cord.

out over the posterior aspect of the sac and if the proper cleavage plane has been reached the separation of the two is simple. During this separation the sac may be accidentally torn. This is of no importance if recognized immediately but if not the remainder of the separation may be very complicated and occasional operators on hernias meet most of their difficulties in not appreciating this complication. A linen tape is now placed about the cord which is held aside and if the sac apparently extends into the scrotum it should be opened and passing one's finger through the opening to the bottom of the sac ascertain by feeling the testicle whether it is of the congenital or acquired type. If the former the sac is cut across and by making gentle divergent traction on both the upper part of the sac and the cord the separation is continued upwards to the internal ring. A blunt retractor placed beneath the internal oblique muscle exaggerates the size of the ring and allows a still higher separation. The neck of the sac is now well exposed to be sure no omentum or intestine is protruding and transfixed. The transfixing suture also includes the transversalis fascia. After ligation grasp the neck of the sac with forceps and cut the ligature before ablating the sac. This eliminates the possibility of the ligature slipping and the open neck retracting up under the muscle, subsequent recovery being very difficult. The lower end of the sac may be dissected out and excised or just enough tissue may be left to form a new tunica vaginalis. This procedure usually causes considerable oozing which must be thoroughly controlled before allowing the testicle to drop back in the scrotum. Leaving the lower end open in situ is rarely followed by a hydrocele and we are inclined not to disturb it. If the sac is of the acquired type but extends well down into the scrotum we usually remove it, but again meticulous care must be used to control all oozing. Post-operative scrotal hematomata are always due to careless non-observance of this precaution.

If the testicle has been brought into the wound during the separation of the sac unusual care must be taken to be sure it is replaced in its normal position. The number of misplaced testes after a simple hernia repair are greater than one, not having seen a large number of post-operative results, could possibly imagine.

If the sac contains irreducible omentum or intestine it is wise to open it as soon as exposed and make no attempt to separate the sac from the cord until its contents are ascertained and the possibility of their reduction determined.

Many excellent authorities believe that the high ligation of the sac is all that is necessary for the radical cure of hernia in children. While recurrences are rare, if the sac is properly removed, our statistics show that they are unquestionably higher when the cord has not been transplanted. The internal oblique and transversalis muscles are sutured to Poupart's ligament with interrupted sutures of chromic or fine kangaroo tendon. It is wise to introduce the lowermost suture first. The lower angle of the wound is retracted and the cremaster pulled one side, exposing Poupart's ligament at its insertion into the spine. It is only by observing this procedure that the structures of the lower angle of the posterior wall of the canal can be properly approximated. Three or four sutures passing from the muscle above to the shelving border of Poupart's ligament below complete the repair of the posterior wall. It is essential that the structures should be approximated without tension. For many years Doctor W. B. Coley has advocated placing one suture above the cord, his theory being that this was the one weak spot in the Bassini operation. Our feeling is that if the suture internal to the cord does not properly close the ring it should be employed. Forceps are now applied to the pillars of the external ring and the external oblique closed with a continuous suture of chromic or fine kangaroo tendon. The skin wound is closed loosely with interrupted sutures of silkworm gut, care being taken to include the deep layer of the superficial fascia. Our preference is for the Stewart stitch which simultaneously approximates the deeper structures and the skin edges. We do not advocate closing the fascia separately as we firmly believe the loose approximation of all the tissues together allows the escape of any accumulated serum. A moderate amount of gauze firmly fixed with adhesive plaster is applied after palpating the testicle to be sure it lies in its normal position. In young children, whose dressings are liable to be contaminated with urine or feces a thin layer of cotton sealed with collodion is applied with the usual gauze dressing added. Diapers should not be used as excretions are more readily observed without them.

The sutures are removed in seven days, the child remains in bed ten days and is discharged at the end of the second week.

Direct inguinal hernia occurs very rarely in children. Our statistics at the Ruptured and Crippled Hospital are as follows:

In 5850 operations for inguinal hernia in male children up to the age of thirteen there were 24 direct hernias and 6 in which both a direct and indirect sac were found.

In 748 female children there were no cases of direct hernia.

The Bassini operation effects a satisfactory cure as we have observed no recurrences following it.

Adults — Mechanical Treatment. *Injection of Paraffine* — This method is simply mentioned to be condemned. It is a relic of bygone days before satisfactory operations had been devised to effect a radical cure and is only used by charlatans.

Truss Treatment. The number of permanent cures by this method is relatively slight but until the laity has been educated not to believe the exaggerated claims made by the vast majority of truss makers, many will still cling to this form of treatment. If the patient selects this method of relief as previously stated in the mechanical treatment of hernia in children any truss that is comfortable and retains the rupture is satisfactory. The frame truss is probably the best but the French and Knight cross body truss will often prove effectual. If there is a tendency for the hernia to slip down underneath the pad a perineal strap may prevent this complication. A very large scrotal hernia can only be properly retained by a modification of the French truss made to measure with a large triangular pad properly fitted to the individual case with a perineal strap added to prevent slipping. By careful attention to cleanliness and changing the pads whenever they become saturated with perspiration irritation of the skin may be prevented.

A truss should be removed at night after the patient is in bed and reapplied in the morning before he arises, care being taken to be sure the rupture is reduced before adjusting the truss.

Operative Treatment for Indirect Inguinal Hernia. All surgeons agree that the high ligation of the sac is a very essential part of the operation for radical cure of indirect hernia. To prevent a dimple forming at the site of ligation Macewen pleated the upper part of the sac and anchored it to the muscle above the internal ring. If care is taken to free the sac well within the ring and ligate it as high as possible this procedure will not be necessary. The most important step in the radical cure is the restoration of the obliquity of the canal. Transplantation of the cord with the suturing of the internal oblique and transversalis muscles to Poupart's ligament answers this requirement. The Bassini operation meets these two essential steps satisfactorily and we feel it is the best operation devised for indirect inguinal hernia.

The details of the technique have been described under the operative treatment in children and only the important points as they differ in adults will be enlarged upon. (See page 22.)

After incising the aponeurosis of the external oblique special care must be taken in reflecting the outer leaf to expose Poupart's ligament all the way down to its insertion into the pubis and the inner leaf far enough backward to expose at least three quarters of an inch of the internal oblique muscle. This reflection should also extend down to the pubis, which means that the lower part of the aponeurosis is separated from the anterior sheath of the rectus.

After dissecting the sac from the cord well within the internal ring always insert one finger through the neck to palpate the posterior wall of the canal to be sure no direct sac accompanies the indirect and to ascertain the condition of the transversalis fascia and the presence or absence of the conjoined tendon. If definitely weak or relaxed or if the conjoined tendon is absent the case will fall into the group of direct hernia and should be treated accordingly as will be described later. Given a satisfactory transversalis fascia and well developed conjoined tendon after ligating the sac and closing the opening in the transversalis fascia (Figure 6) we are ready for the repair of the posterior wall.

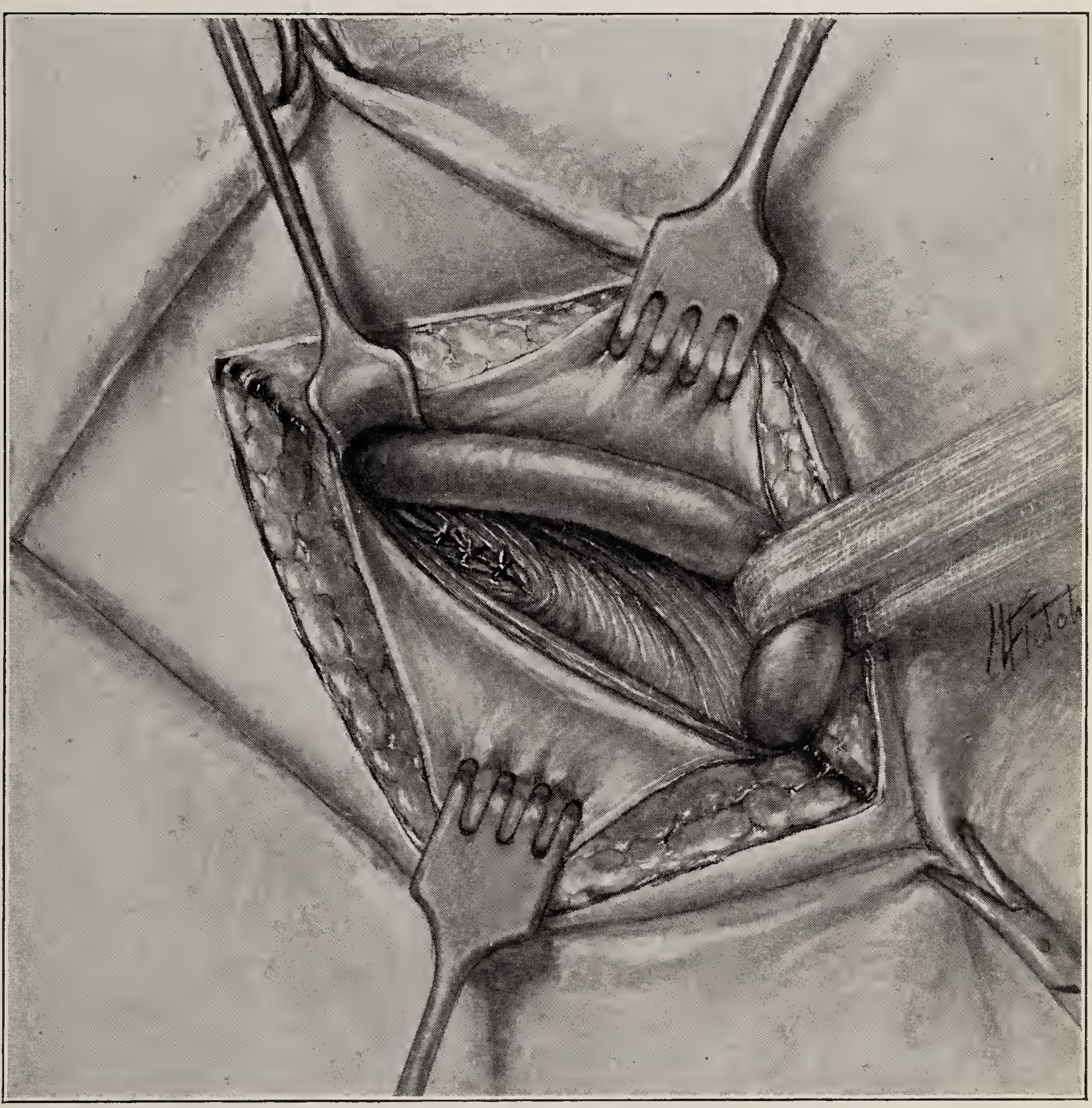

Fig. 6. Closure of transversalis fascia.

The lower suture (Figure 7) is introduced behind the cord first passing the index finger of the left hand beneath the internal oblique and transversalis muscles at the lower angle of the posterior wall and bringing

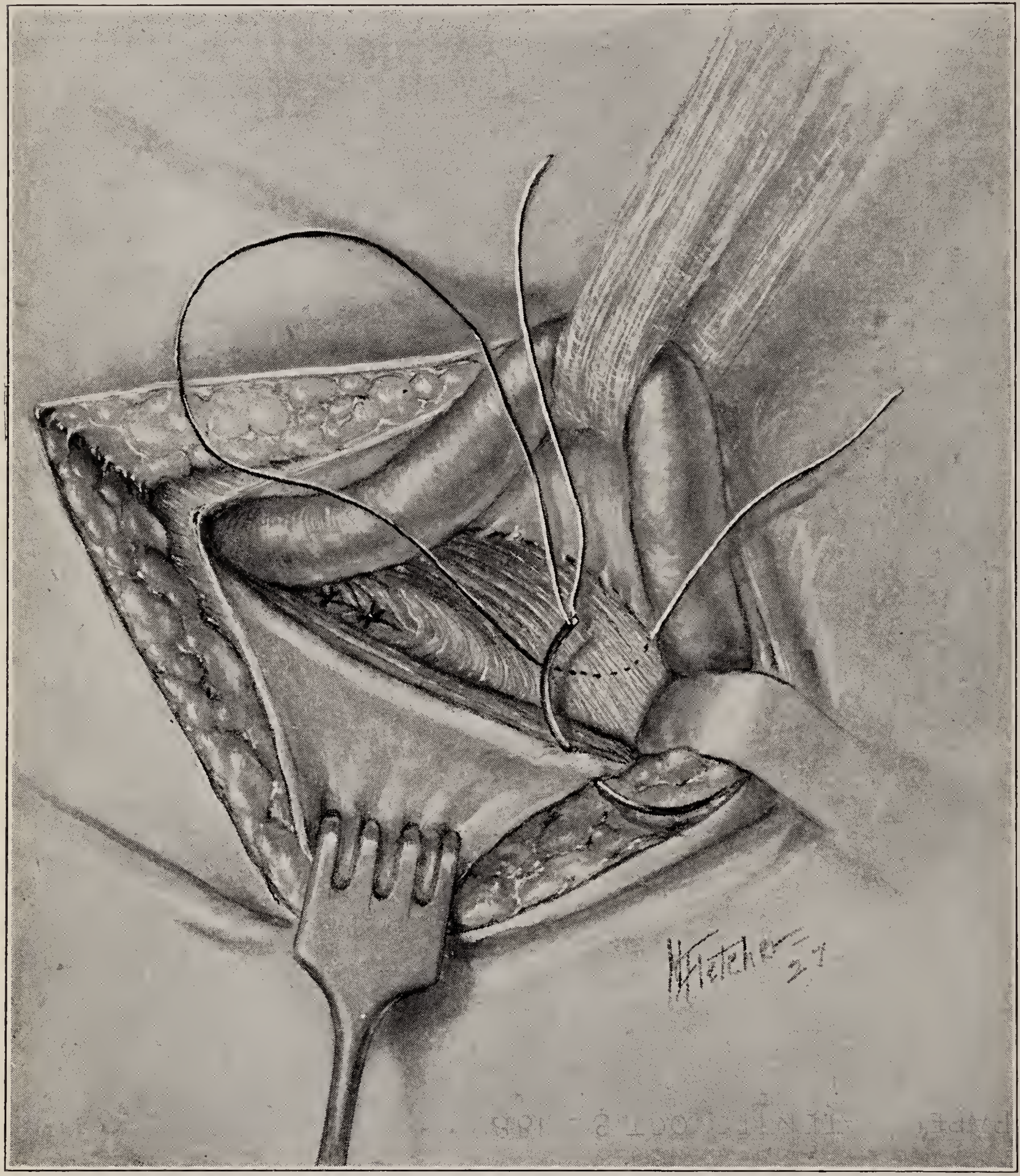

Fig. 7. Introduction of first suture in Bassini repair.

the needle gently against the finger after getting a good bite of muscle. The suture now passes through Poupart's ligament at its insertion, the needle being carried down to the periosteum. After the first suture is tied the posterior wall is palpated from within to be sure no dimple exists which may be the precursor of a subsequent direct recurrence. The remaining sutures are inserted from below upward behind the cord about one-half inch apart between muscle and the shelving border of Poupart's ligament. (Figure 8.) These do not include the cremaster as we feel it wiser not to interpose a frayed out muscle between two well developed structures. Care must be taken to be sure no fatty tissue is interposed and that there are no gaps between the sutures.

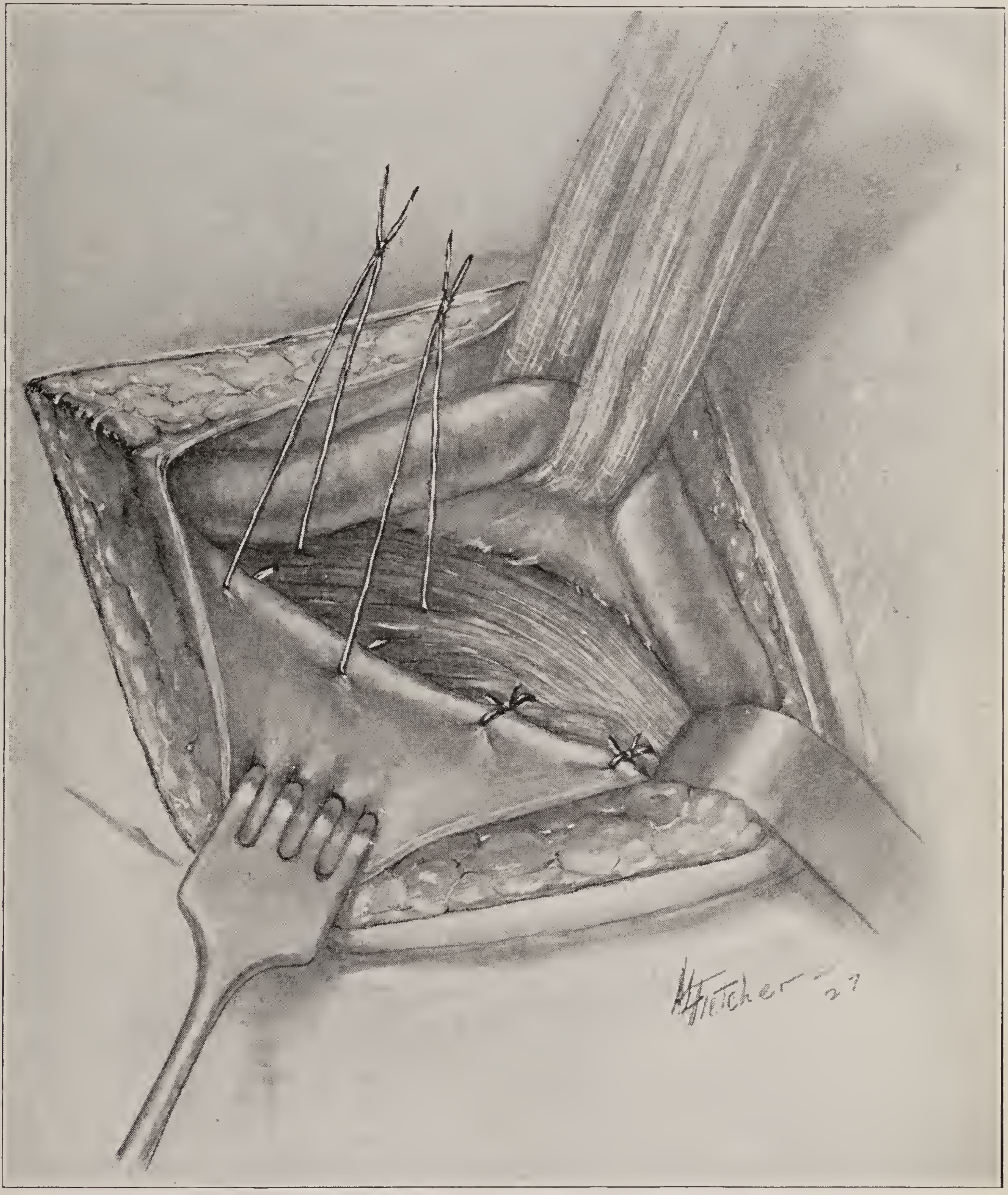

FIG. 8. Posterior sutures introduced and lower two tied.

Too much stress cannot be laid on the importance of approximating muscle to Poupart's ligament without tension. If there is considerable tension one of two things will probably happen: either the knots will slip or the suture cut through the muscle. Breaking the table in the middle with flexion of the thighs and possibly the elevation of the shoulders is a great aid. If this procedure is employed the patient must be transported and placed in bed in the same flexed position.

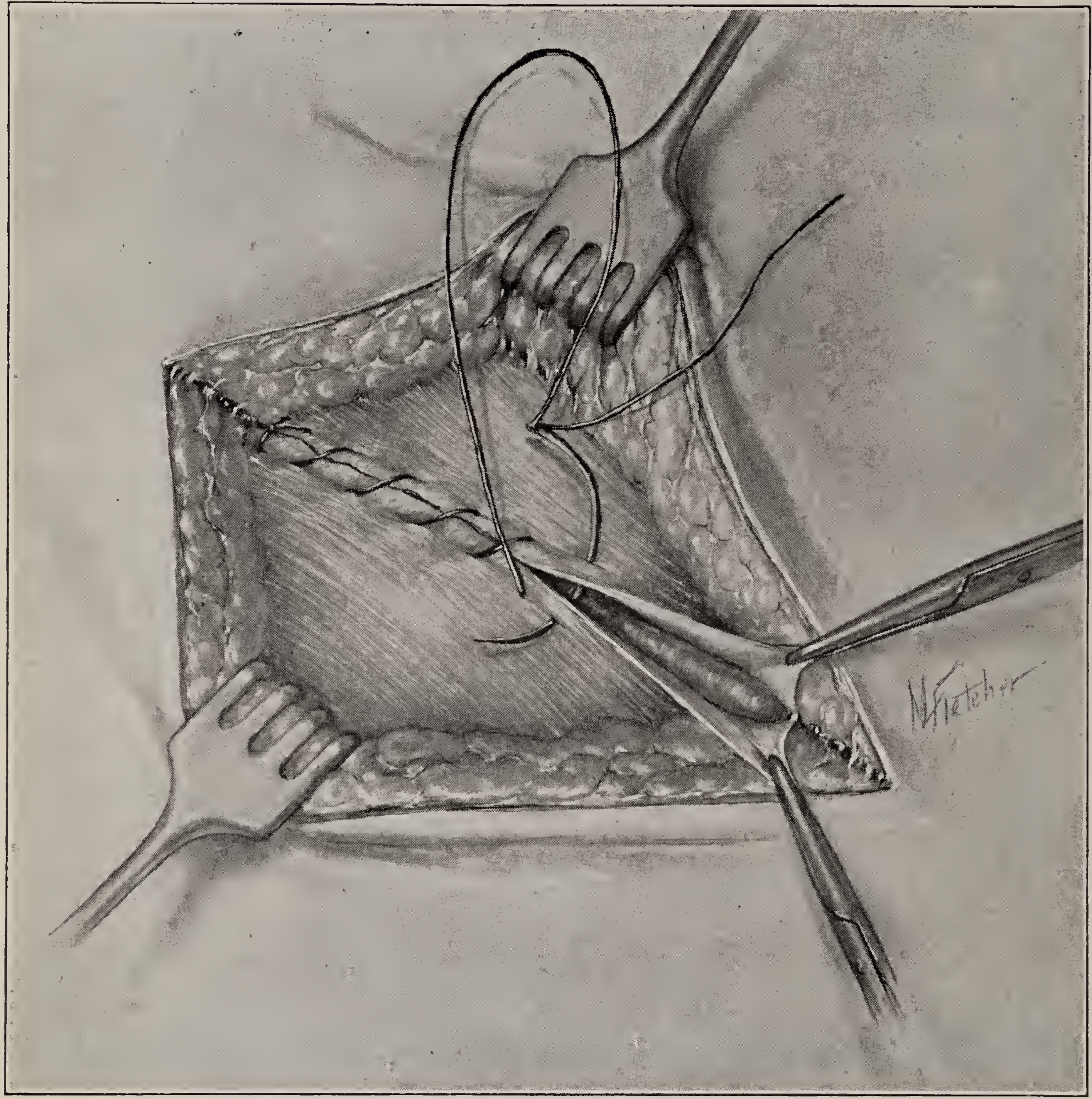

FIG. 9. Closure of external oblique.

The last suture touches the cord as it is held vertical to the plane of the abdomen and if we feel the internal ring is still relaxed an additional suture is placed above the cord. Before inserting the sutures in the posterior wall all fatty tissue should be removed from the cord and if there are an unusual number of dilated veins a portion of these should be excised. The closure of the external oblique and skin is performed as described under the technique in children. (Figures 9 and 10.)

Dressings. Before applying the dressing insert a forceps in the lower angle of the wound and express all blood and air. A moderate amount of gauze is applied so arranged as to exert equal pressure over the entire wound. (Figure 11.) This is fixed with broad strips of adhesive plaster covering the entire dressing, with an additional narrower strip passing down toward the perineum to prevent contamination from below. Care must be used not to have this strip too tight when the thigh is extended. If the sac has extended into the scrotum the latter should be supported by a bridge. The sutures are removed on the seventh day. The patient

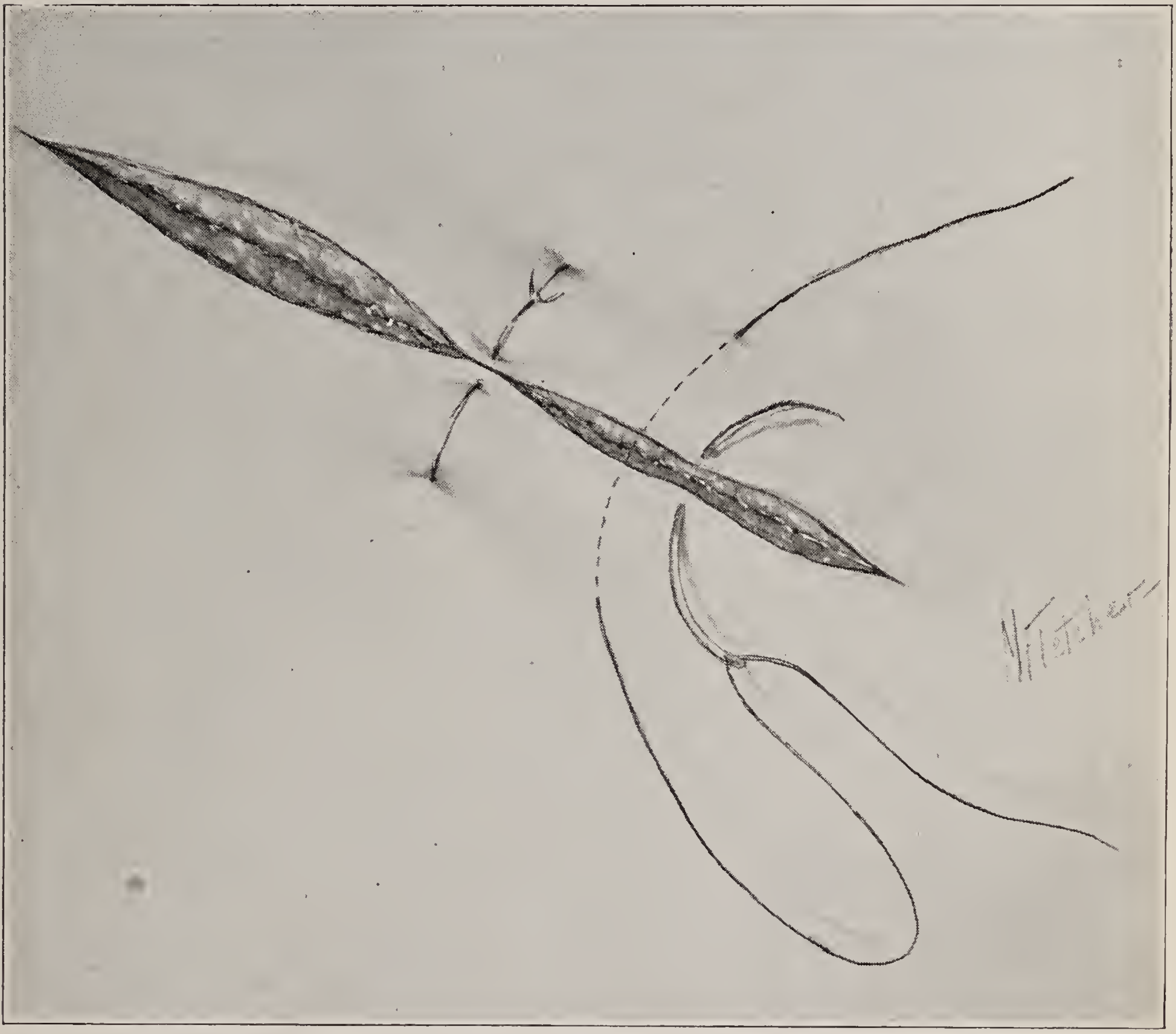

Fig. 10. Skin suture.

is out of bed in from eleven to twelve days and leaves the hospital in two weeks.

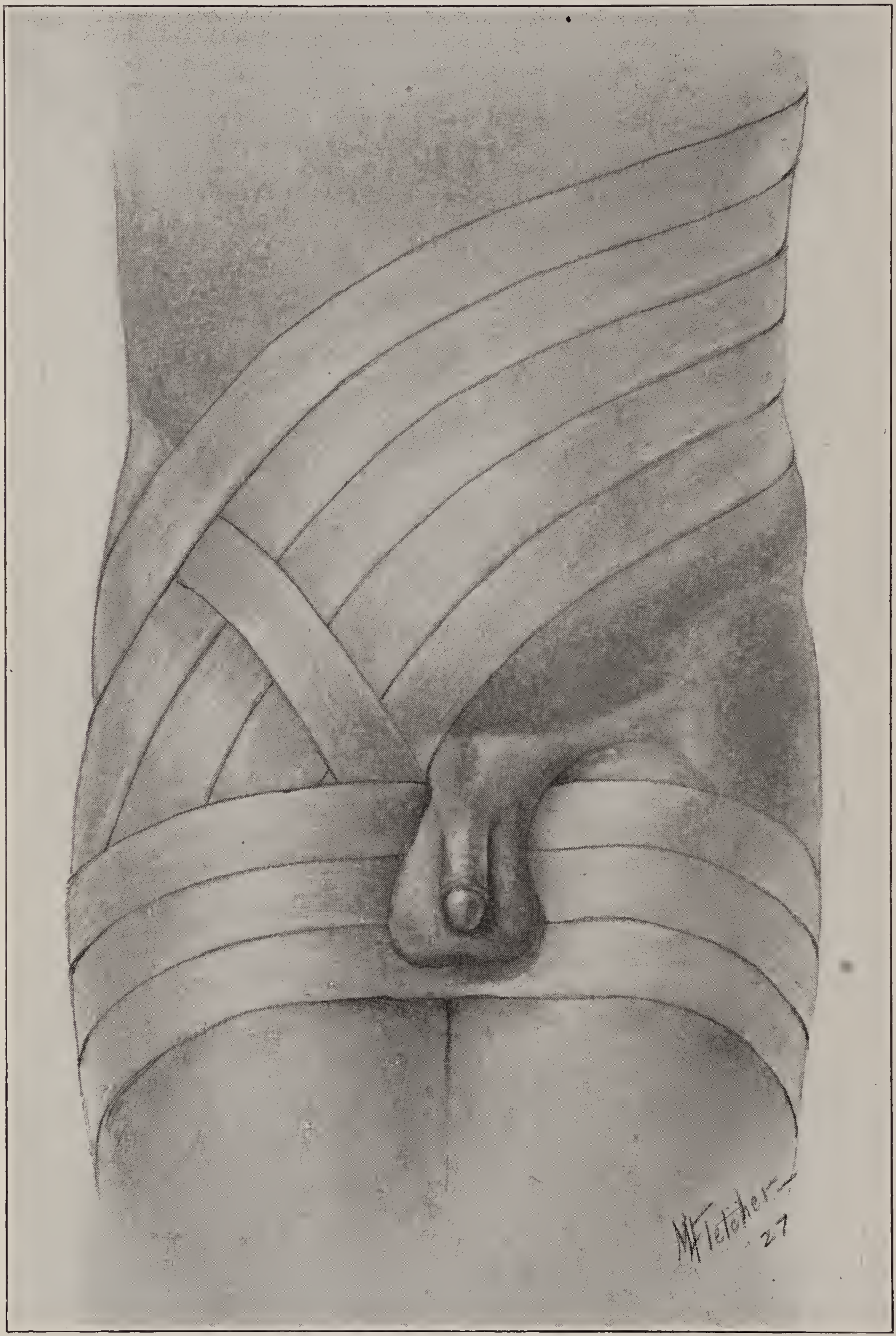

FIG. 11. Dressings fixed by adhesive plaster and scrotum supported by bridge.

HALSTED OPERATION FOR INDIRECT INGUINAL HERNIA

In 1889 Halsted described an operation in which he narrowed the cord by excising most of the veins. The upper leaf of the external oblique with the internal oblique and transversalis muscles were sutured with mattress sutures to Poupart's ligament, the sutures continuing through the lower leaf of the external oblique and tied on its outer surface, and the cord lying on the aponeurosis covered by the skin and superficial fascia.

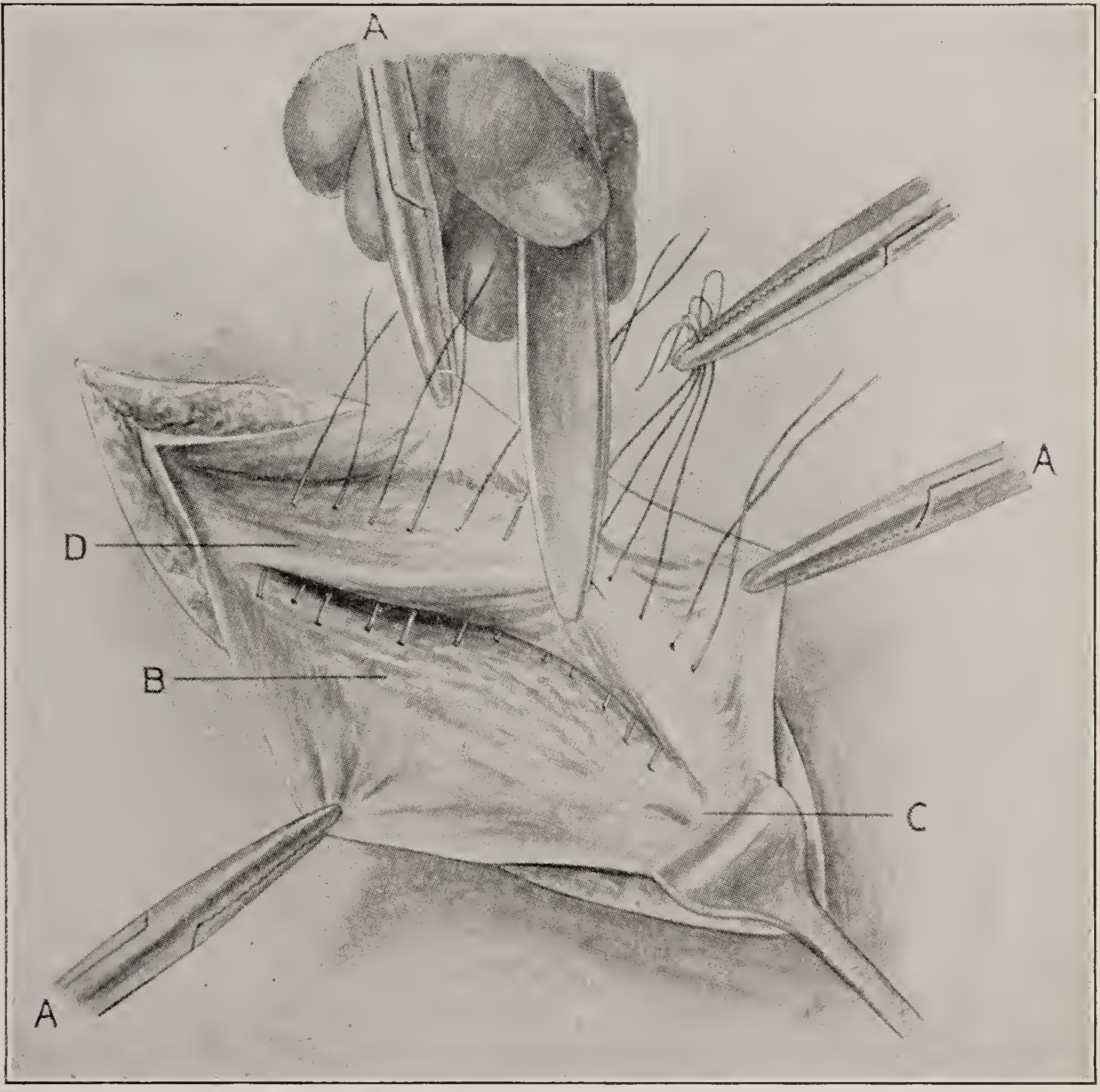

Fig. 12. Halsted's Method of overlapping the various layers involved in Operations for radical cure of Inguinal Hernia. A,A,A, Forceps holding apart the split external oblique aponeurosis; B, Cremaster layer with mattress sutures drawing it under the edge of the internal oblique muscle; C, Spermatic cord; D, Internal oblique muscle.

The excision of the veins and transplantation of the cord were abandoned and at present the Halsted operation is as follows: The sac is opened and separated from the cord by sharp dissection without disturbing the latter which is not transplanted. Mattress sutures unite the conjoined tendon, internal oblique and transversalis muscles to the cremaster and transversalis fascia, the latter being drawn up under the former, (Figure 12) next the conjoined tendon and internal oblique muscles are sutured to Poupart's ligament with mattress sutures, the cord emerging at the lower angle. (Figure 13.) As a final step the external oblique is overlapped with mattress sutures. (Figures 14, 15, 16.)

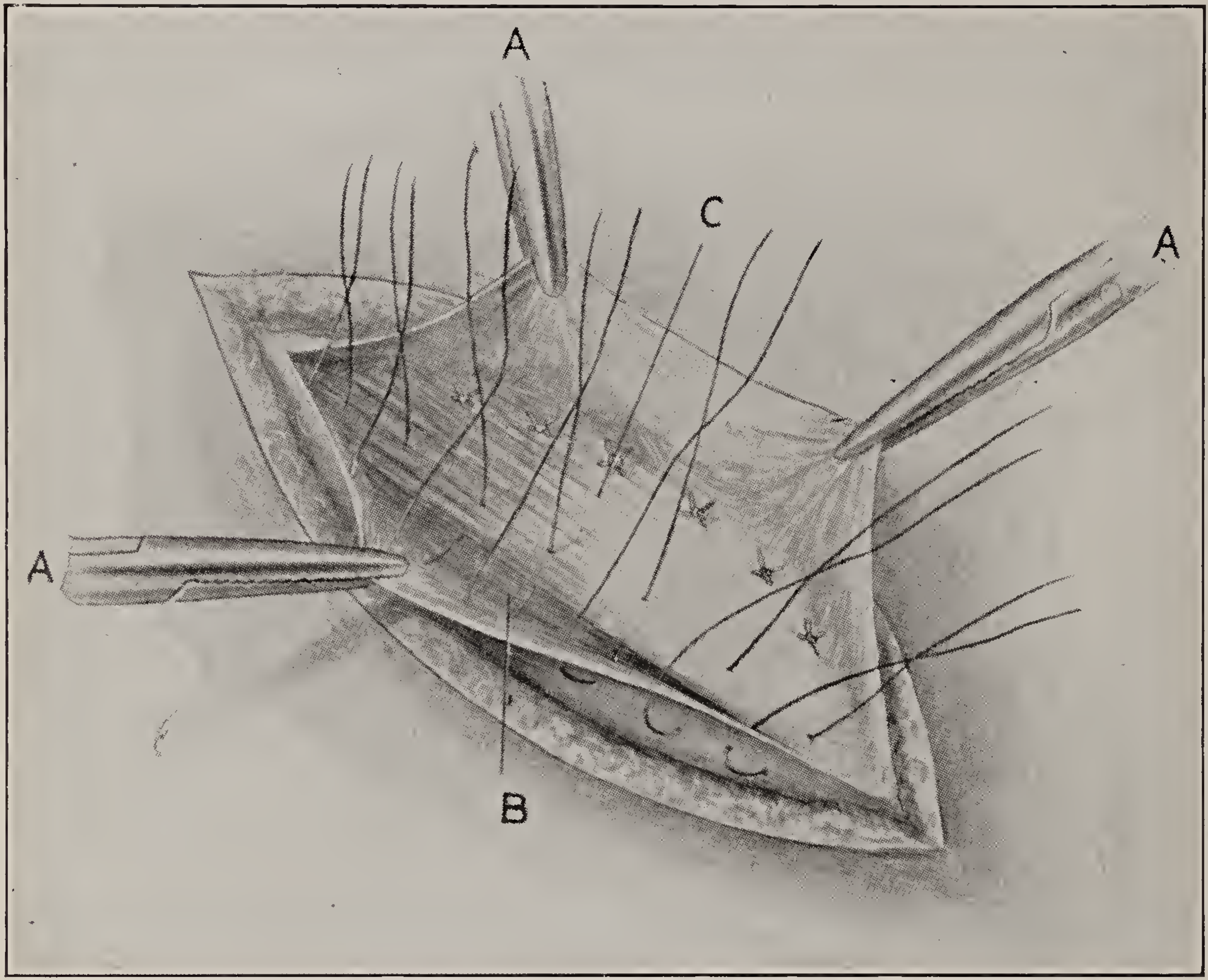

Fig. 13. Halsted's Overlapping Method. A,A,A, As in Fig. 12; B, Poupart's ligament, to which the internal oblique, C, is being drawn down over the cremaster layer by mattress sutures; C, Internal oblique muscle.

Ferguson's operation consists of a modified Bassini without transplantation of the cord as the essential feature. Bull and Coley described a similar operation several years before. After separating the sac without disturbing the cord and ligating it the internal ring is narrowed by suturing the transversalis fascia. The internal oblique and transversalis muscles are sutured to Poupart's ligament leaving an aperture at the lower angle for the cord to emerge. The aponeurosis of the external oblique is overlapped.

TORECK'S OPERATION

After exposing the inguinal canal in the usual manner dissect the vas, vessels and sac clear of connective tissue up to the internal ring until the sac is seen to emerge between the vessels and vas, the vessels being above the sac, the vas below.

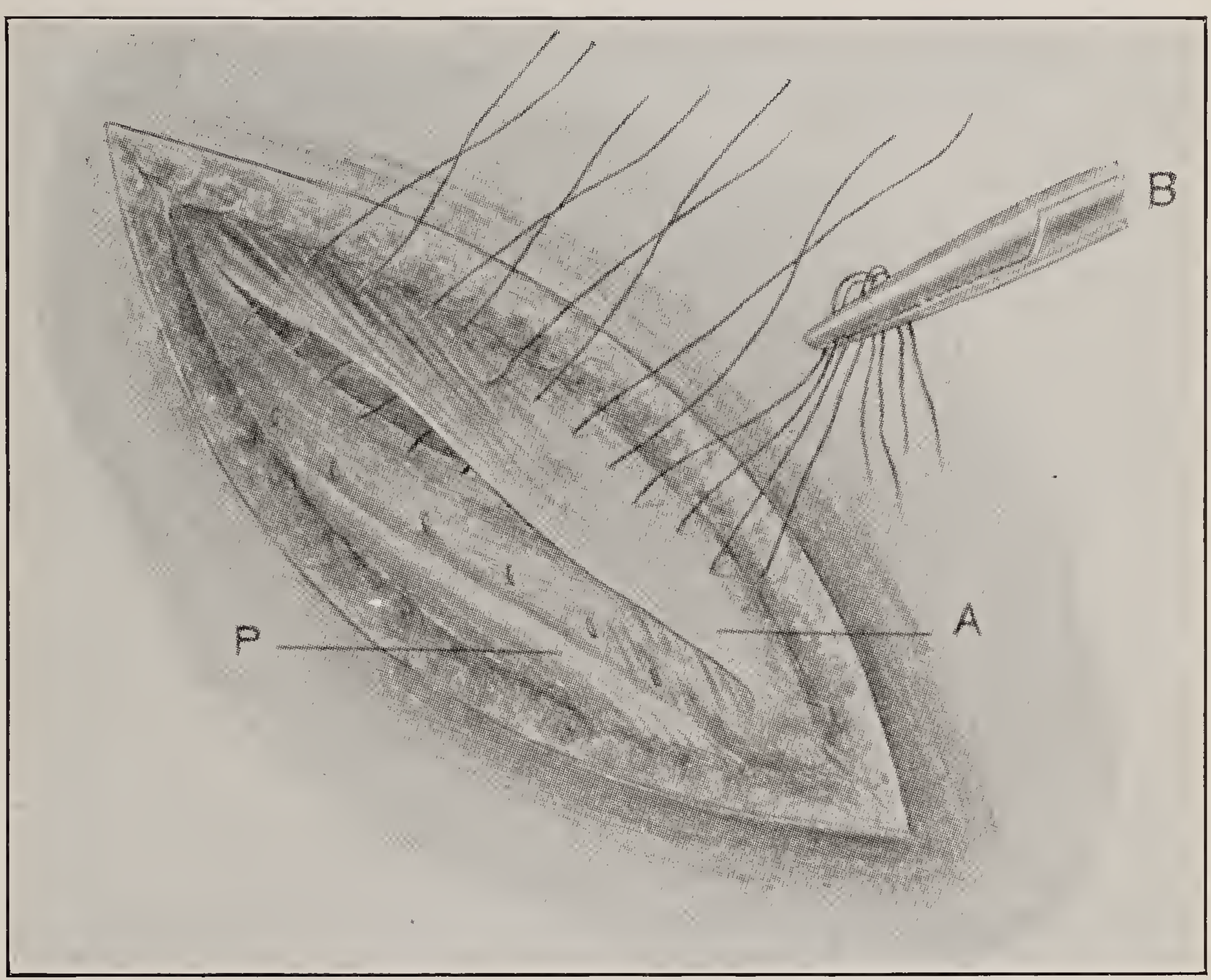

FIG. 14. Halsted's Overlapping Method. A, Lower leaf of external oblique muscle being drawn under the upper leaf by mattress sutures, B; P, Poupart's ligament.

Remove all lipomata and other fatty tissue as well as connective tissue from the region of the internal ring, allowing no structure except vas and vessels to be partly inside and partly outside abdomen.

Transfix sac, tie and cut off.

Lift cremaster well out of the way, do not include it in the suture. If bulky divide or resect it.

Before introducing the sutures the spermatic vessels are placed in the uppermost angle and the vas in the lowermost angle of the internal ring. Two or three sutures unite the internal oblique and transversalis muscles

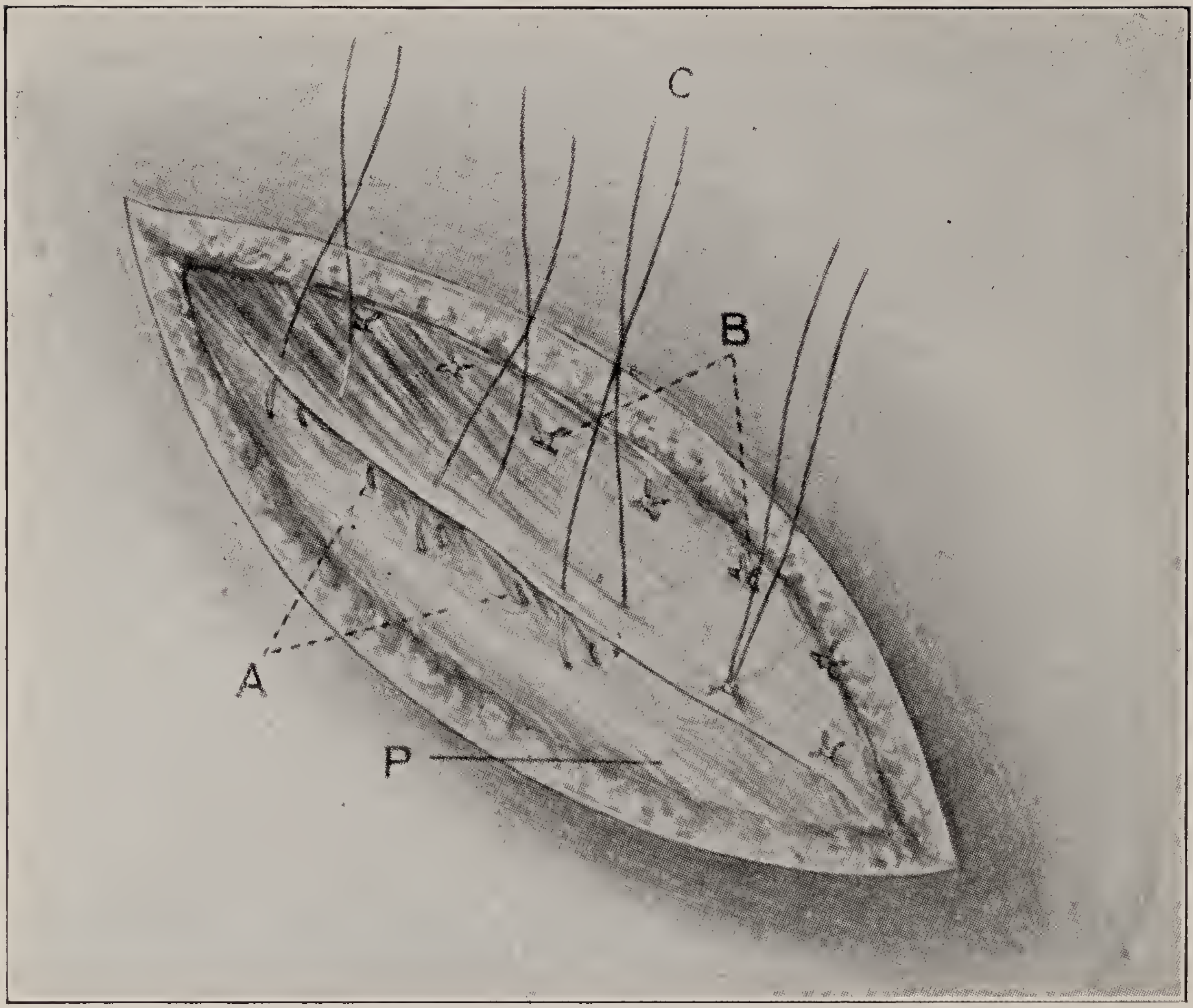

FIG. 15. Halsted's Overlapping Method. A, Edge of the upper layer of the external oblique muscle being united to the under layer, B, by ordinary interrupted sutures, C, passing through its edge and through Poupart's ligament, P.

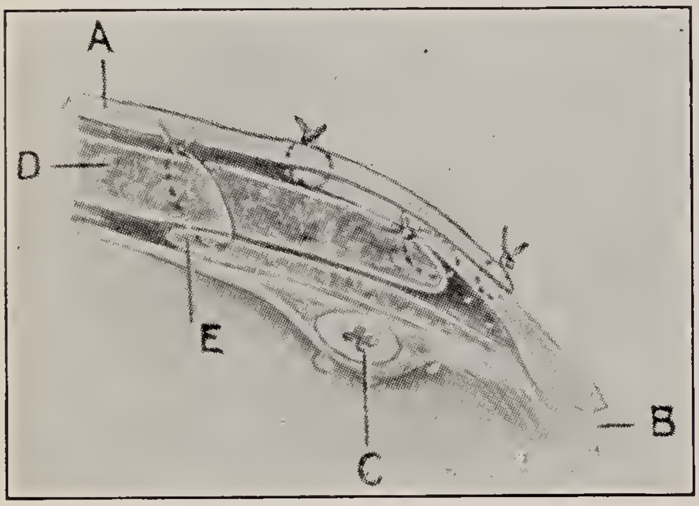

FIG. 16. The arrangement of the layers when the operation is completed. A, Upper layer of the external oblique; B, Lower layer; C, Cord; D, Internal oblique; E, Cremaster.

to Poupart's ligament between them. Below the vas a sufficient number of interrupted sutures are introduced to completely close the posterior wall of the canal, the lower two sutures being of #26 silver wire.

Toreck reports the end results of nearly 600 traced cases with only two recurrences. While we have had no experience with this method his end results entitle it to serious consideration.

Large scrotal hernias of long standing with a wide neck and sagging down of the posterior wall so that the internal ring lies almost behind the external ring are not suitable cases for the Bassini operation. Some form of plastic repair of the posterior wall of the canal with stronger tissue than already exists in these patients is essential for a radical cure. Living fascial sutures are indicated in this type of case and the method of operating is similar to the radical cure of a direct sac with living sutures.

For those not advocates of this method of repair, we suggest reinforcing the posterior wall by the Wyllys Andrews technique which will be described under the operative treatment of direct hernia.

OPERATIVE TREATMENT OF INGUINAL HERNIA IN THE FEMALE

The inguinal canal is exposed as in the male and the sac is found intimately related to the round ligament.

While separation of the sac without fraying of the round ligament may be difficult, the best method is, to open the sac at once and, passing the finger down to the bottom, begin the separation at this point, as here the structures are less adherent. If the round ligament has been largely destroyed during the separation in its course through the canal the ligature transfixing the sac should include the ligament at its emergence from the internal ring. By suturing the neck of the sac to the muscles above the ring the ligament is anchored at this point and its function as a pelvic ligament preserved.

The lower end of the sac must always be removed lest a hydrocele develop. This complication develops rarely in the male, but in the female we have found from clinical experience it not to be at all uncommon. The round ligament is ignored in suturing the muscles to Poupart's ligament and the closure is accomplished as in the male without having to deal with the cord.

Direct hernia in the female is infrequent but the same principles of closure apply as in the male.

OPERATIVE TREATMENT FOR DIRECT INGUINAL HERNIA

The problem of the radical cure of direct hernia is an entirely different one from indirect hernia. A direct sac or a direct bulge with poor musculature, relaxed transversalis fascia and probably absence or attenuation of the conjoined tendon is not a suitable case for the Bassini or any other operation whose definite aim is the cure of the indirect hernia. The posterior wall of the canal must be reinforced by stronger tissues than those that normally make up its anatomy.

Many operations have been and constantly are being devised to reinforce the posterior wall. Downes in 1920 published a classical article on the subject and described an operation which was probably the best up to that time.

Downes Operation. Usual skin incision but carried lower down to get a good exposure in the region of the external ring. After delivering the cord look carefully for a small indirect sac in addition to the direct sac, After freeing the direct sac, it is opened at its outer side (Figure 17.)

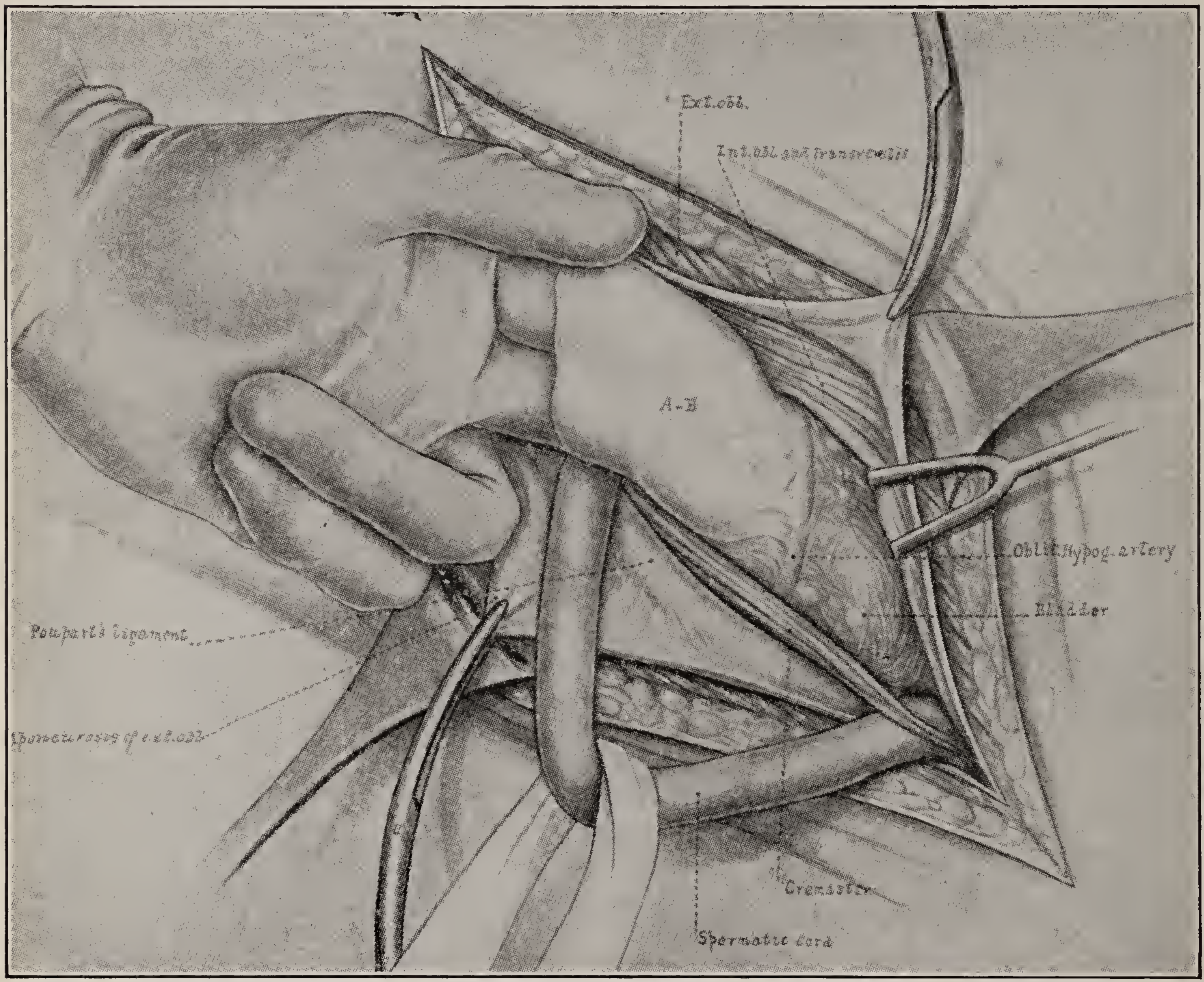

Fig. 17. Sac opened showing properitoneal fat and bladder. (Courtesy of Archives of Surgery.)

to avoid the bladder, strip the properitoneal fat well away from the sac drawing its base flush with the opening in the transversalis fascia and transfix with #1 chromic. If possible the rent in the transversalis fascia is closed as a separate layer with continuous chromic. (Figure 18.) A retractor is placed low down under the continuation of the internal oblique and transversalis muscles and the sharp margin of the rectus muscle located with the fingers. The sheath is opened along its anterior border and the muscle exposed from about the level of the internal ring down to its pubic attachment. (Figure 19.) Three to four sutures of kangaroo tendon unite it to the deepest part of Poupart's ligament, being inserted from below upwards. (Figure 20.) The internal oblique and transversalis muscle are sutured to Poupart's ligament from above downwards, each suture picking up a small bite of rectus and catching Poupart's ligament just superficial and between those of the first row. (Figure 21.) The external oblique is overlapped behind the cord. (Figure 22.)

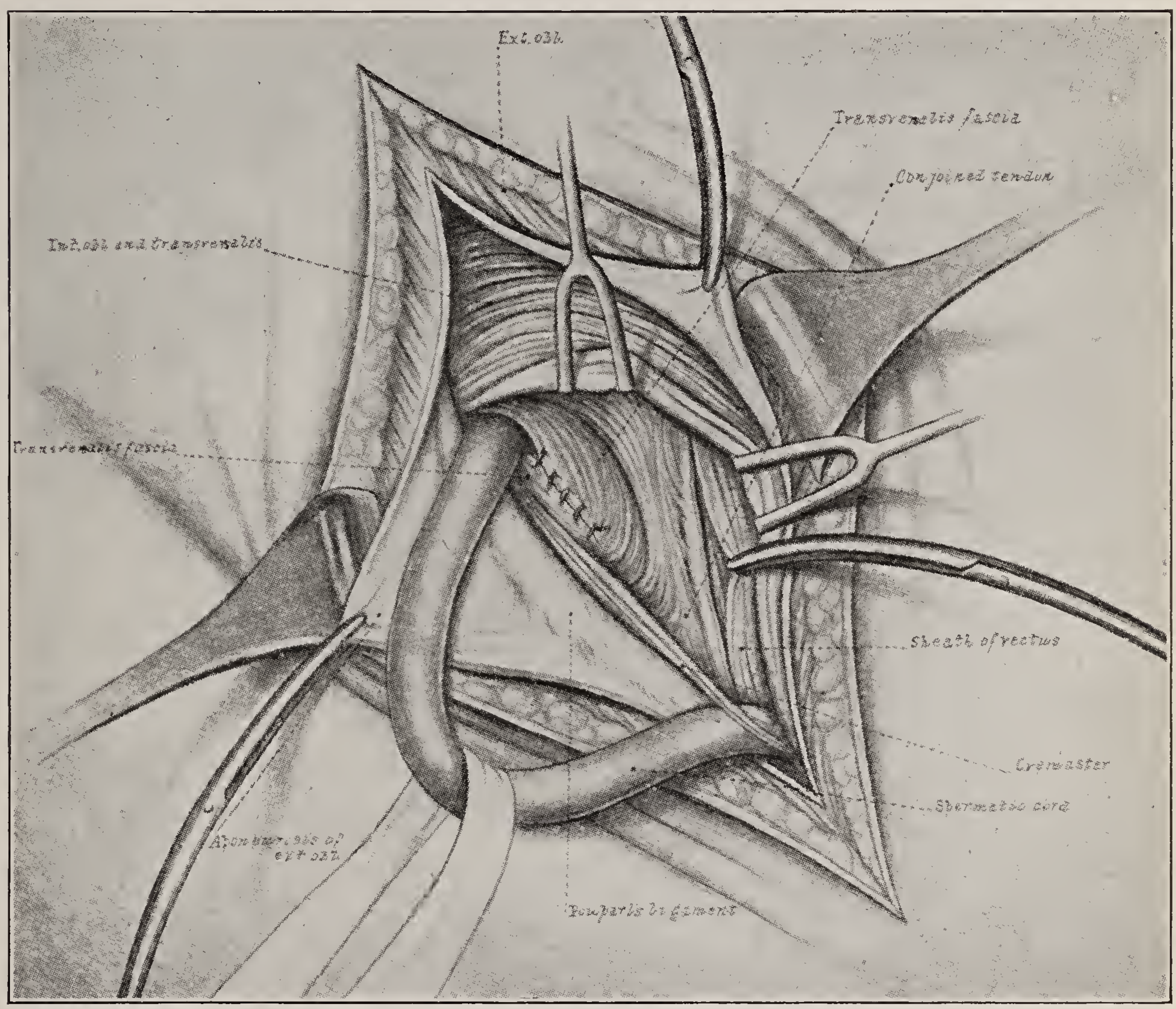

FIG. 18. Closure of transversalis fascia as a separate layer; sheath of rectus opened. (Courtesy of Archives of Surgery.)

Utilization of the rectus sheath or muscle or both to reinforce the posterior wall have been described by many surgeons prior to Downes.

Wölfler in 1892 incised the anterior sheath of the rectus and sutured this muscle to Poupart's ligament.

Bloodgood in 1898 incised the rectus sheath for a distance of about two inches and sutured the muscle and sheath with the conjoined tendon and internal oblique to Poupart's ligament.

Halsted, Hotchkiss and Lusk obtained a triangular flap from the anterior sheath of the rectus.

Blake incised the posterior sheath of the rectus along its outer edge, suturing the muscle to Poupart's ligament.

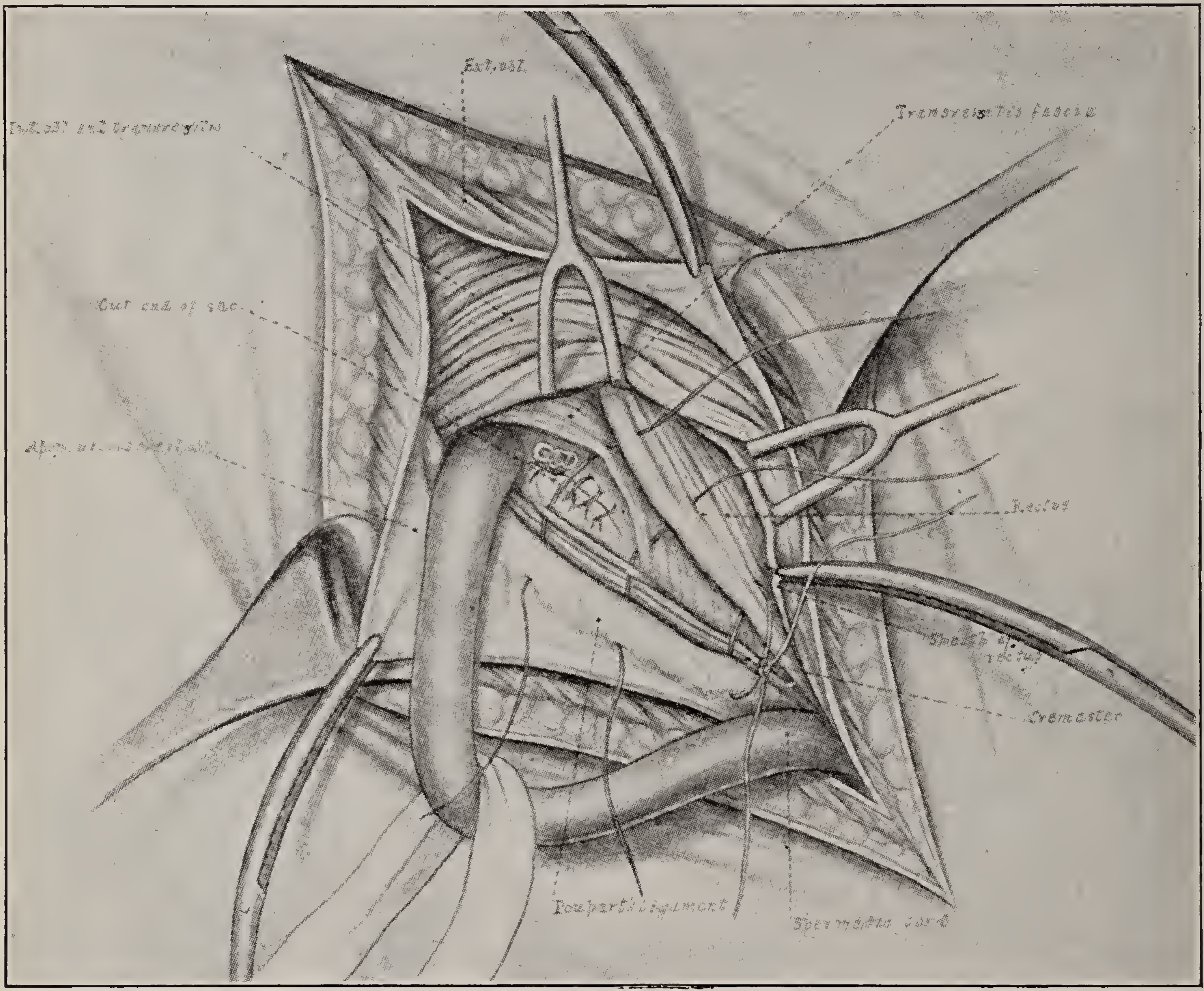

FIG. 19. Rectus muscle exposed, sutures in place. (Courtesy of Archives of Surgery.)

Schley sutured the rectus muscle to Poupart's ligament, next internal oblique and conjoined tendon to Poupart's ligament followed by overlapping the external oblique behind the cord.

Wyllys Andrews Operation. In 1895 and again in 1905 E. Wyllys Andrews described a modification of the Bassini technique which is as follows: The mesial layer of the external oblique is united behind the cord to Poupart's ligament with the internal oblique and transversalis muscles all being included in the suture. The outer leaf of the aponeurosis is sutured over the cord. (Figure 23.) This method reinforces the posterior wall of the canal with a strong fascial layer and is valuable if the transversalis fascia is relaxed or if a small direct hernia exists.

We feel that the external oblique can be more accurately approximated to Poupart's ligament as a separate layer and recommend suturing the internal oblique and transversalis with one row of interrupted sutures and the external oblique with a second row. Often the outer leaf is of insufficient width to suture over the cord and we are content to overlap it behind the cord, the latter lying on the aponeurosis covered by superficial fascia and skin.

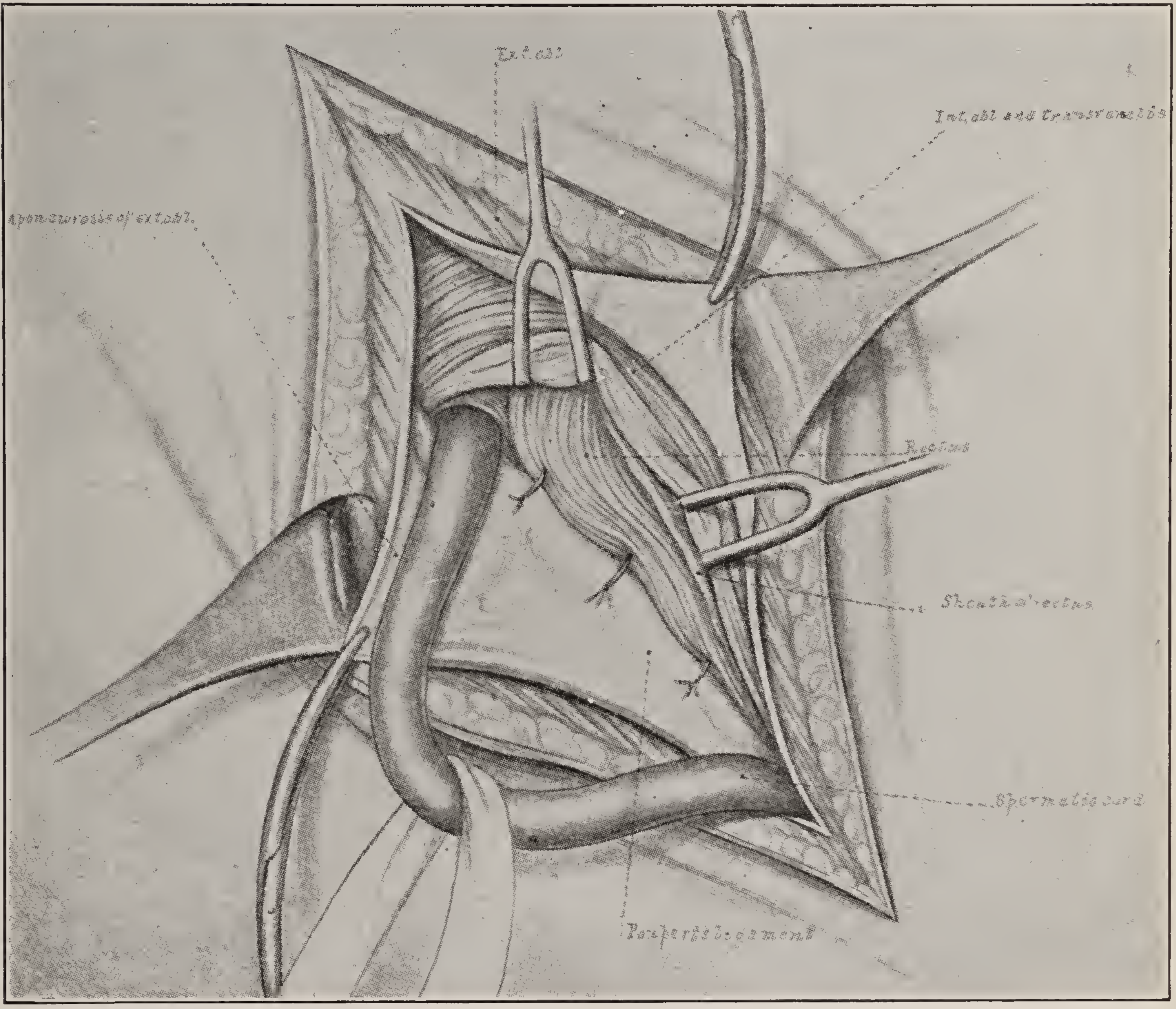

FIG. 20. Rectus muscle in apposition to Poupart's ligament. (Courtesy of Archives of Surgery.)

Edmund Andrews in 1924 described an operation in which only white fascia was utilized. He accepted the theory of Seelig and Chouke that red muscle did not unite to Poupart's ligament as final and evolved the following technique to overcome that failure of union. The transversalis fascia is sutured with a continuous suture to Poupart's ligament from the pubic spine to the internal ring, (Figures 24 and 25) the latter being narrowed leaving only a small opening for the cord. The internal oblique and transversalis muscles are ignored and the upper flap of the external oblique is sutured to Poupart's ligament with interrupted sutures behind the cord (Figure 26), one or two sutures being placed above the latter. These are inserted in such a manner that the knots lie outside the canal. The lower flap of the aponeurosis is sutured over the cord.

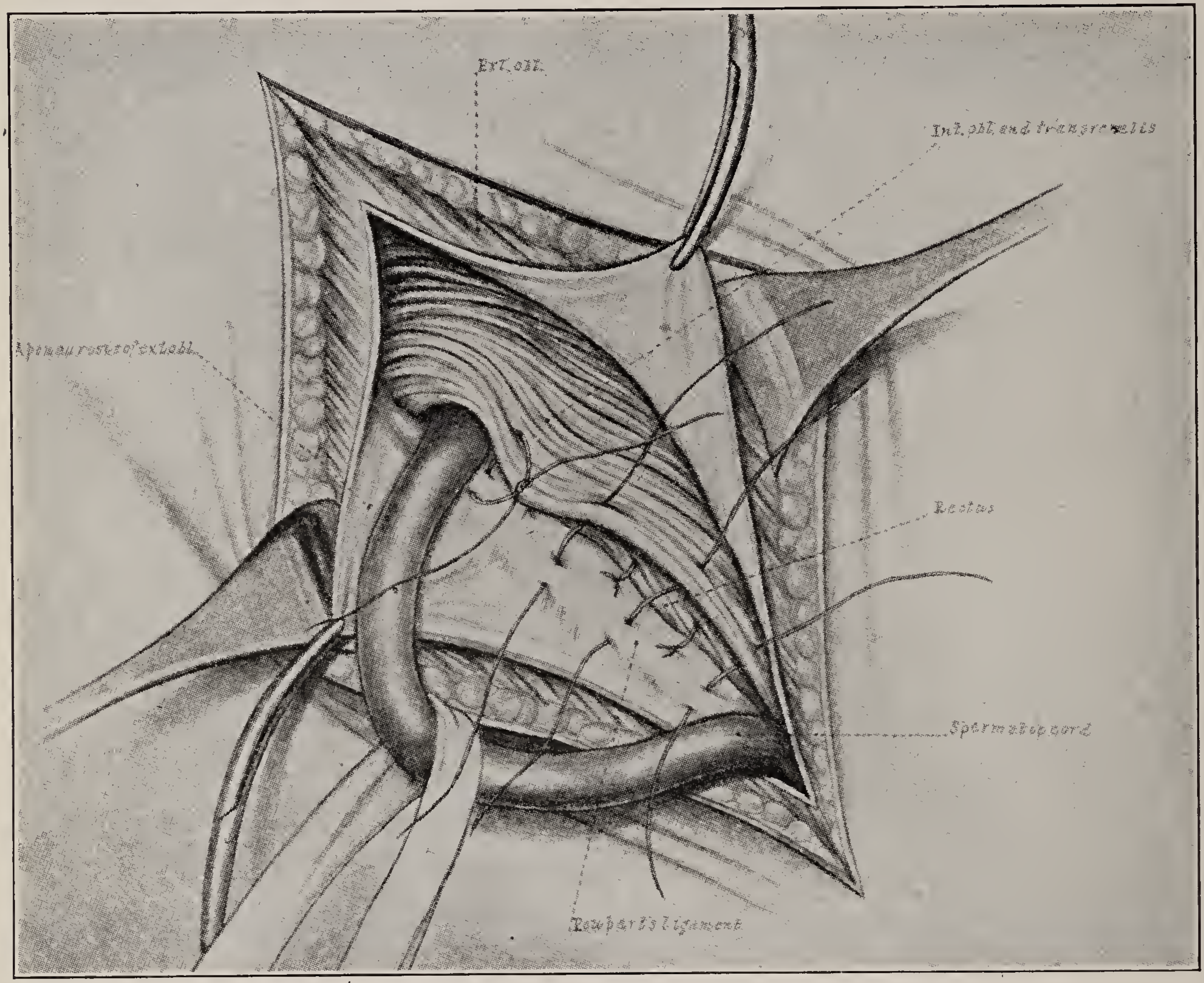

FIG. 21. Bassini operation after rectus transplantation. (Courtesy of Archives of Surgery.)

Whether firm union occurs between red muscle and Poupart's ligament has brought forth considerable discussion. The fact that the majority of recurrent hernias are direct has been argued by those that believe it does not as a point in their favor. Probably if the muscles are brought down under considerable tension or if the sutures are tied too tightly thus interfering with the blood supply union will not take place, but if the structures are properly approximated and no areolar tissue is interposed union undoubtedly does occur in a large majority of cases.

Most surgeons who have operated on a large number of recurrent hernias have probably observed firm union over the outer two-thirds of the canal. The recurrence is usually in the inner third or at the lower angle and the problem seems to us to resolve itself into whether union occurs between conjoined tendon and Poupart's or rectus muscle and Poupart's rather than whether red muscle unite to ligament.

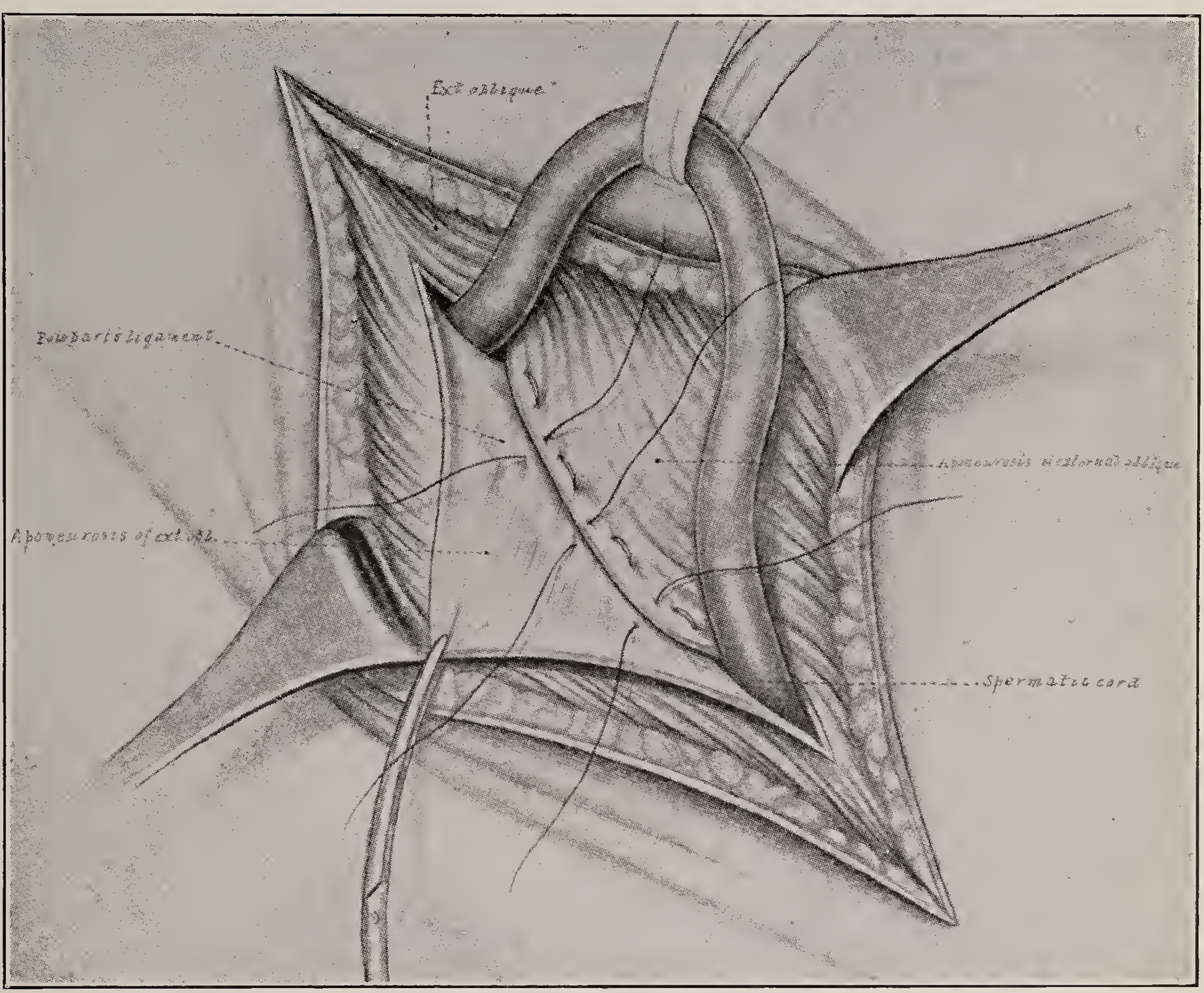

FIG. 22. Suture of external oblique to Poupart's ligament. Continuous suture is preferred to interrupted, as illustrated. (Courtesy of Archives of Surgery.)

RADICAL CURE OF DIRECT INGUINAL HERNIA WITH LIVING FASCIAL SUTURES

The incision should be carried well down to the pubic bone to obtain a good exposure in the region of the external ring. The external oblique is incised near Poupart's ligament as later we plan to suture it to the ligament and desire as wide an internal leaf as is possible. The cord is lifted from its bed and the presence or absence of a small indirect sac accompanying the direct noted. The direct sac is now identified lying internal to the deep epigastric vessels and above and internal to the cord, the two not being closely connected. The sac is easily freed from surrounding adhesions and found to be covered with the transversalis fascia.

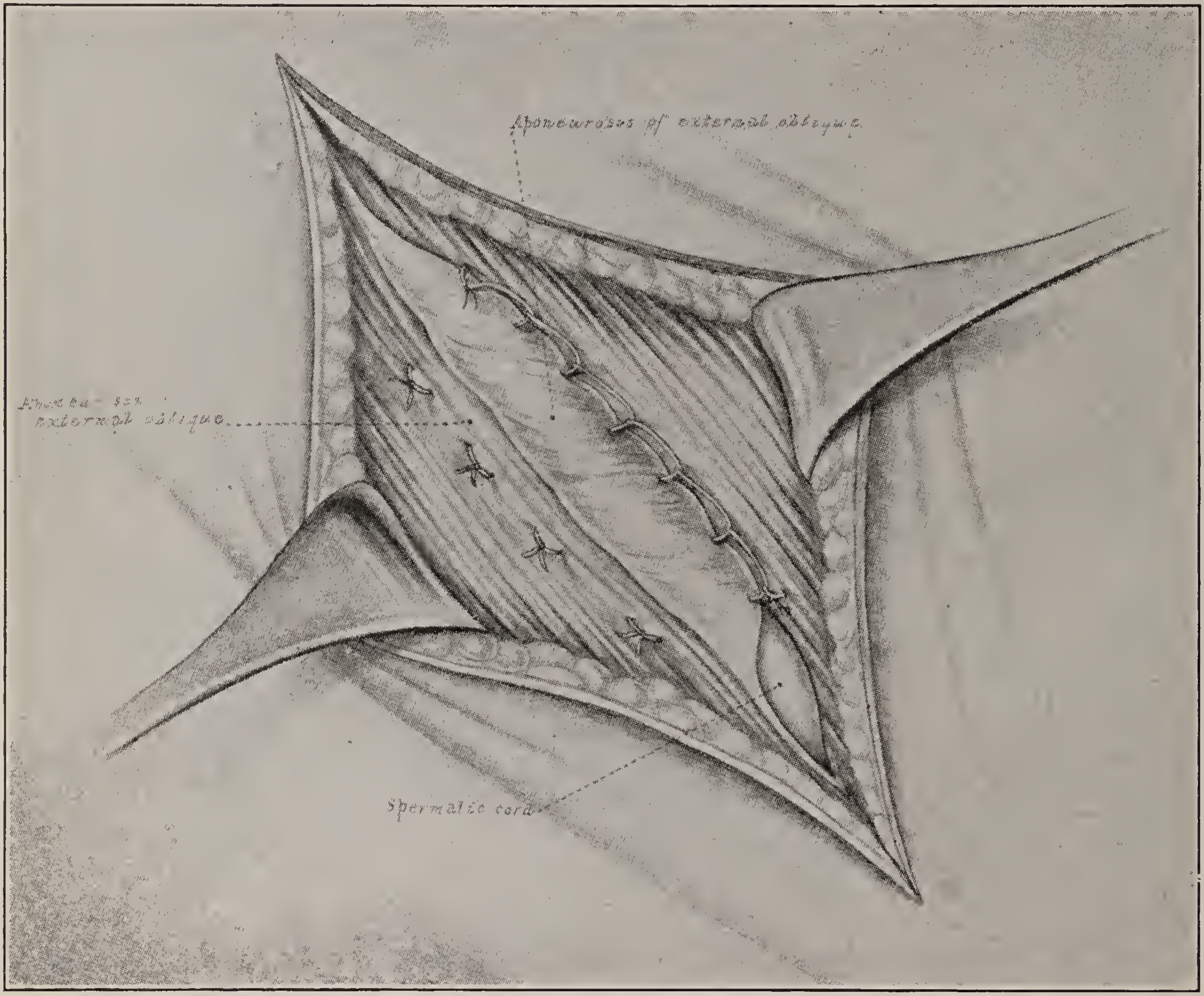

FIG. 23. Andrews operation completed. (Courtesy of Archives of Surgery.)

This is incised, clamps being applied to the upper margin for future identification. The properitoneal fat which is frequently a fairly thick layer is now exposed and indentification of the sac may be rather difficult. It should always be incised on the outer side with a sharp scalpel to avoid injuring the bladder. With one finger in the sac the properitoneal fat is separated from it and on the inner side we usually identify the obliterated hypogastric artery and possibly the bladder. With a little experience the musculature of the bladder can easily be recognized but many surgeons have an unnecessary fear of injuring this viscus and are apt to err by keeping too far away from it. The real danger of injuring the bladder lies in carelessly incising the sac with the scissors. We have never advocated wide stripping of the properitoneal fat from the peritoneum to obtain a very high ligation of the sac. The peritoneal layer is very lax

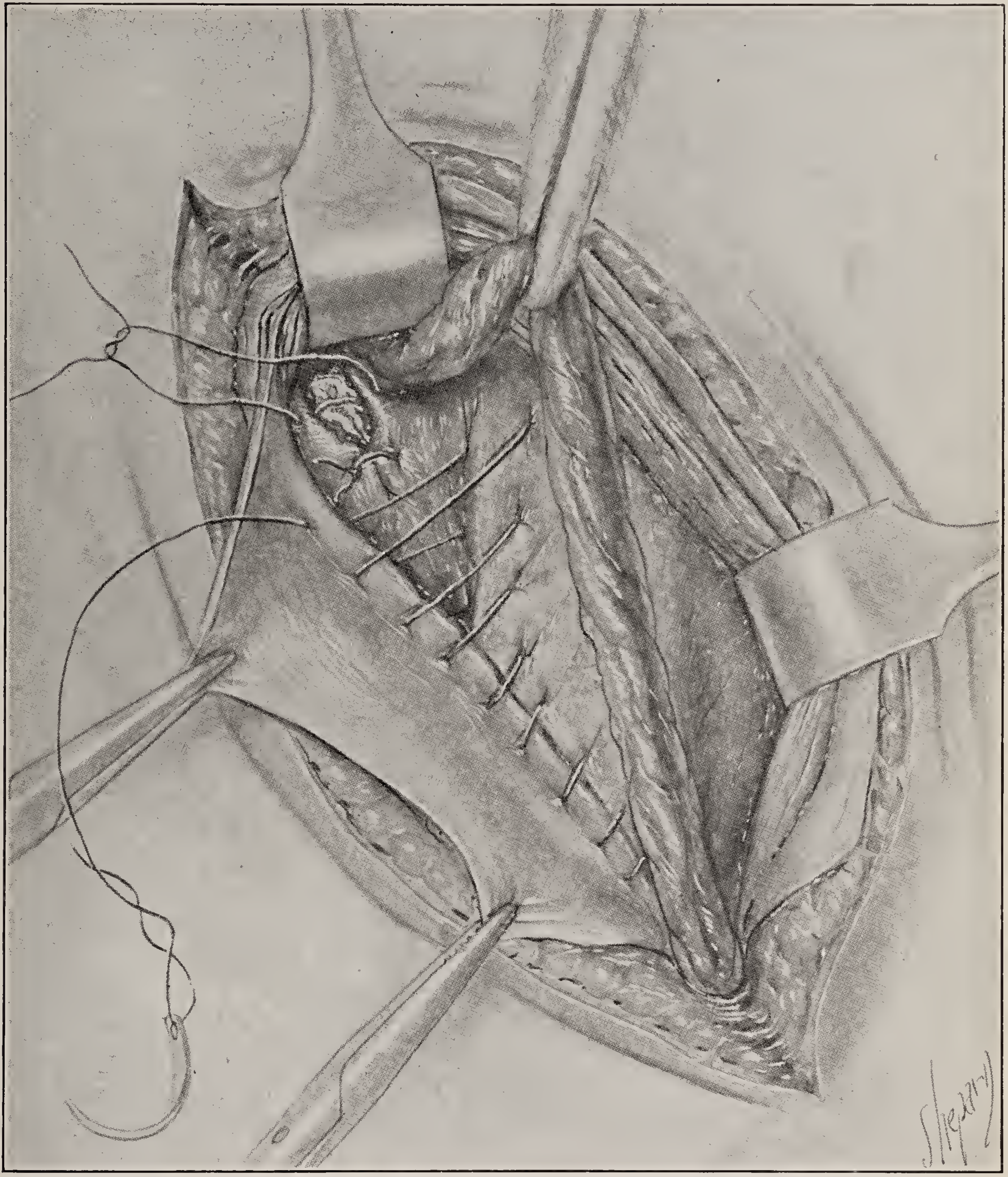

Fig. 24. Transversalis fascia instead of red muscle in deep suture. (Courtesy of Annals of Surgery.)

in this locality and can be pulled down almost indefinitely. The important step is to be sure the sac is freed from the overlying transversalis fascia so that when it is ligated the sac retracts well within this opening in the fascia and is not caught in the suture. All excess properitoneal fat is removed from the cord and if the veins are excessive a portion should

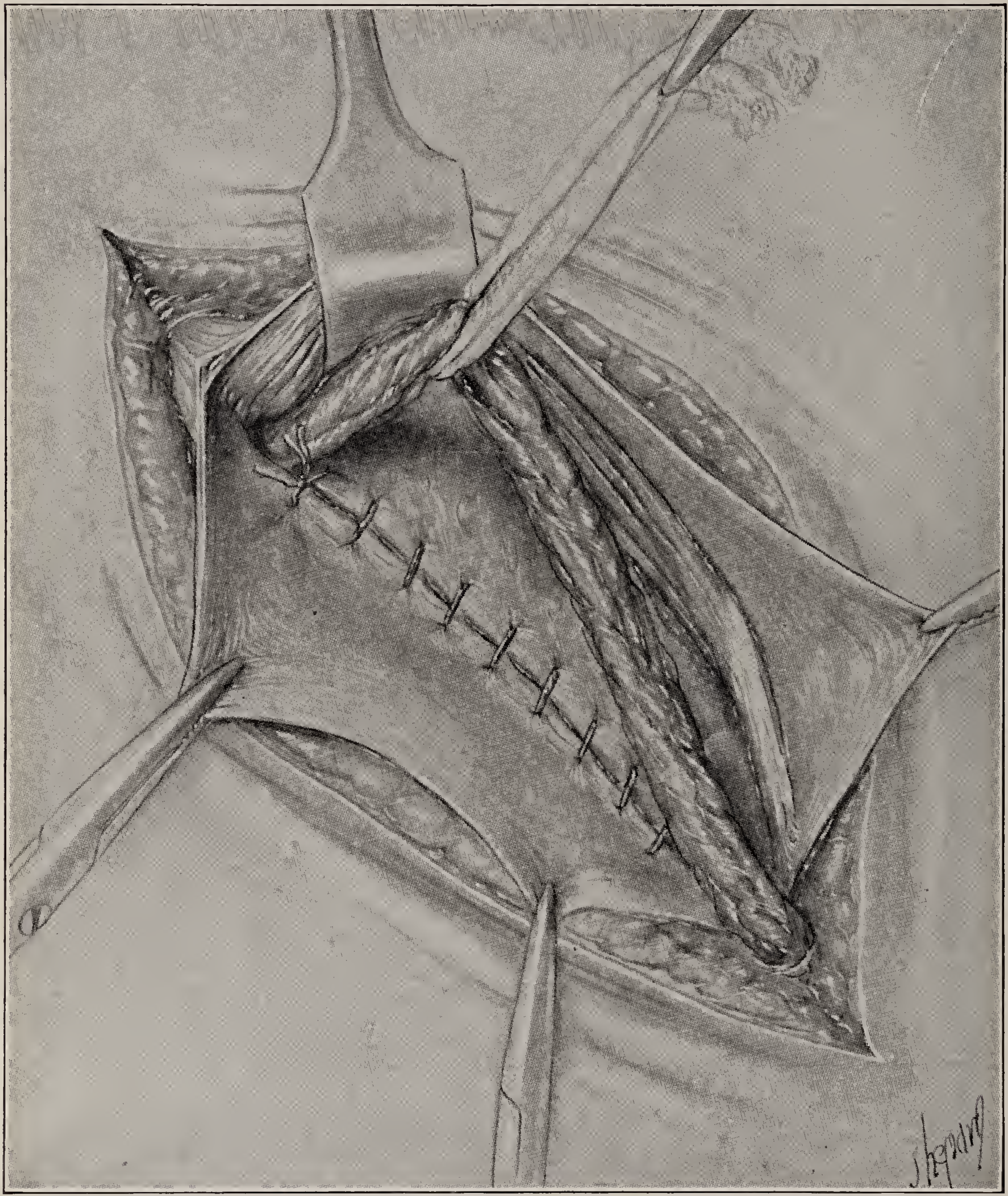

FIG. 25. Deep layers. White fascia sewn to Poupart's, avoiding red muscle. (Courtesy of Annals of Surgery.)

be excised. We do not advocate closing the opening in the transversalis fascia as a separate layer as we wish to include it in our first row of sutures and secure it to Poupart's ligament. Gallie — (Figure 27).

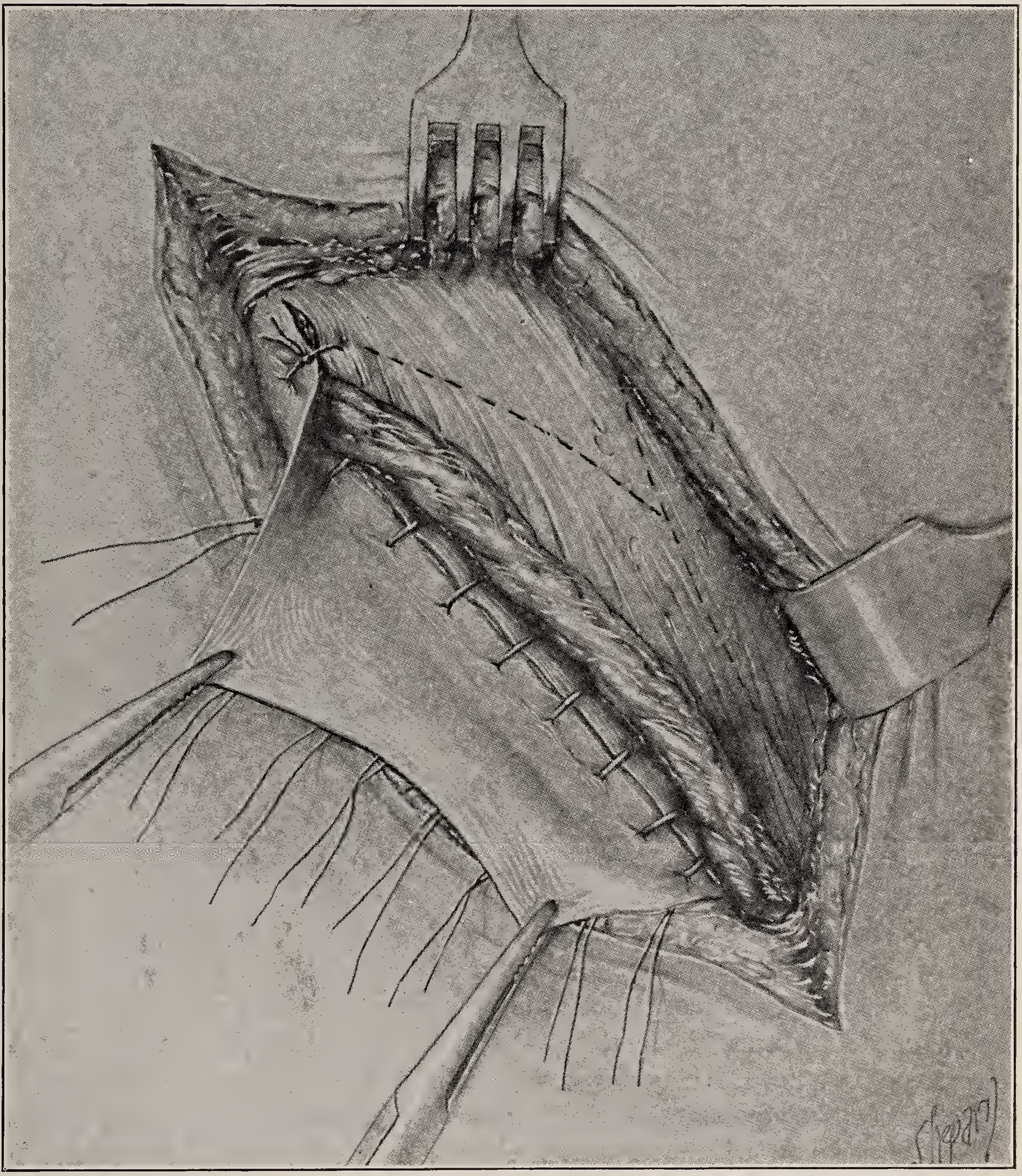

Fig. 26. Additional layer (external oblique aponeurosis) imbricated behind cord. (Courtesy of Annals of Surgery.)

The fascial sutures are introduced as follows: Insert one finger through the opening in the transversalis fascia to act as a guide and pass the needle of the fascial suture through muscle and fascia at the lower angle of the posterior wall. This means that the edge of the rectus is usually included in the first suture. After anchoring the suture clear exposure of the insertion of Poupart's ligament into the pubis is obtained by adequate retraction. The needle is inserted down to the periosteum and the suture passes through the ligament at its insertion into the pubis. Too much emphasis cannot be laid on satisfactory exposure, for without it proper insertion of this most important stitch is impossible. The fascial suture

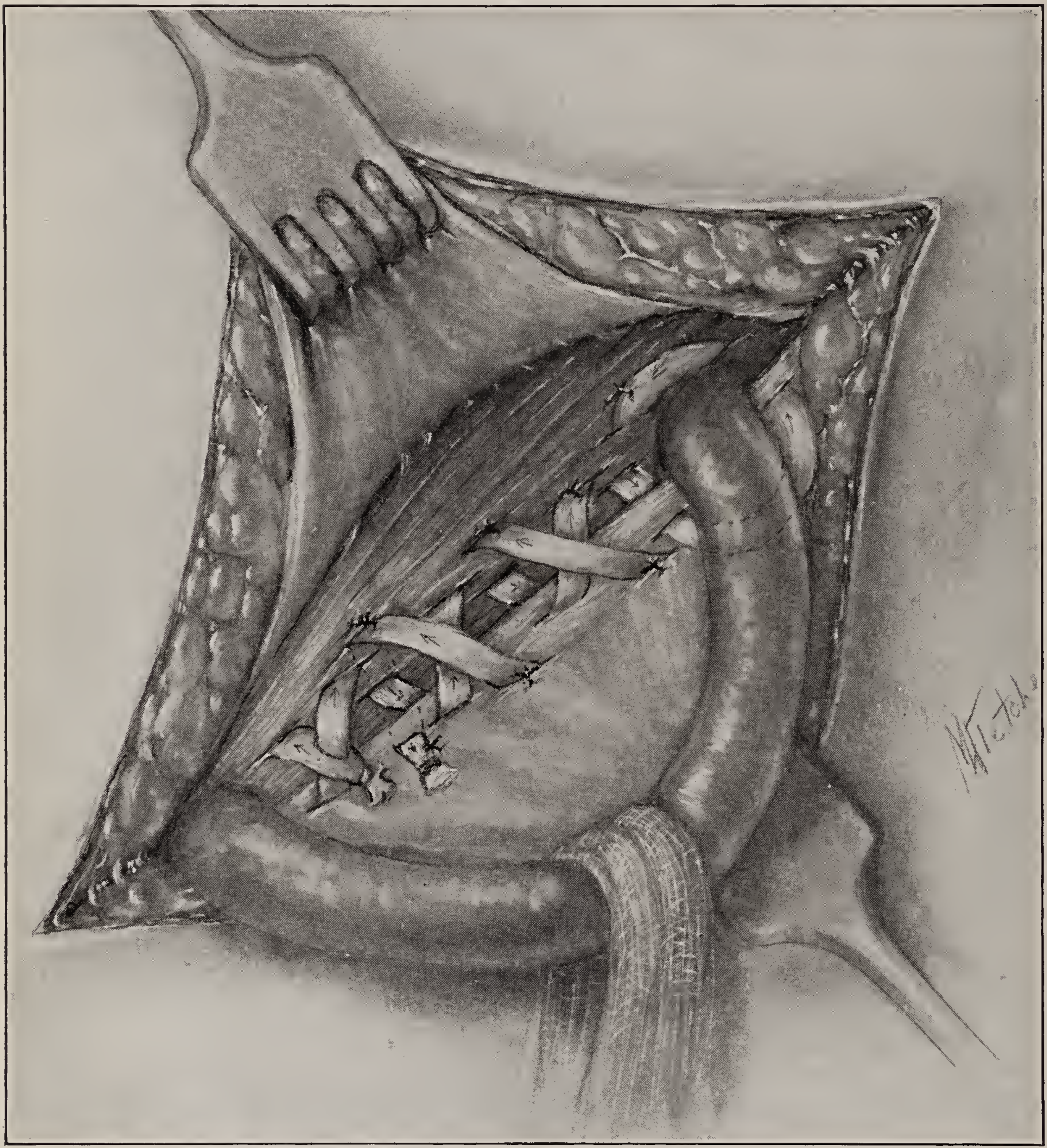

FIG. 27. Posterior wall reconstructed with fascial sutures.

is continuous and a second one is inserted one-half inch above the first, the bite including internal oblique and transversalis muscle and transversalis fascia. The thighs should be flexed to aid approximation and after the second suture is inserted into Poupart's ligament an interrupted suture of chromic catgut is passed through all the tissues united including the fascial suture. This step fulfills two purposes. It anchors the fascial sutures and helps to hold the structures in approximation until the fascia has been incorporated in the tissues. Care must be taken to be sure no tabs of properitoneal fat protrude between the sutures.

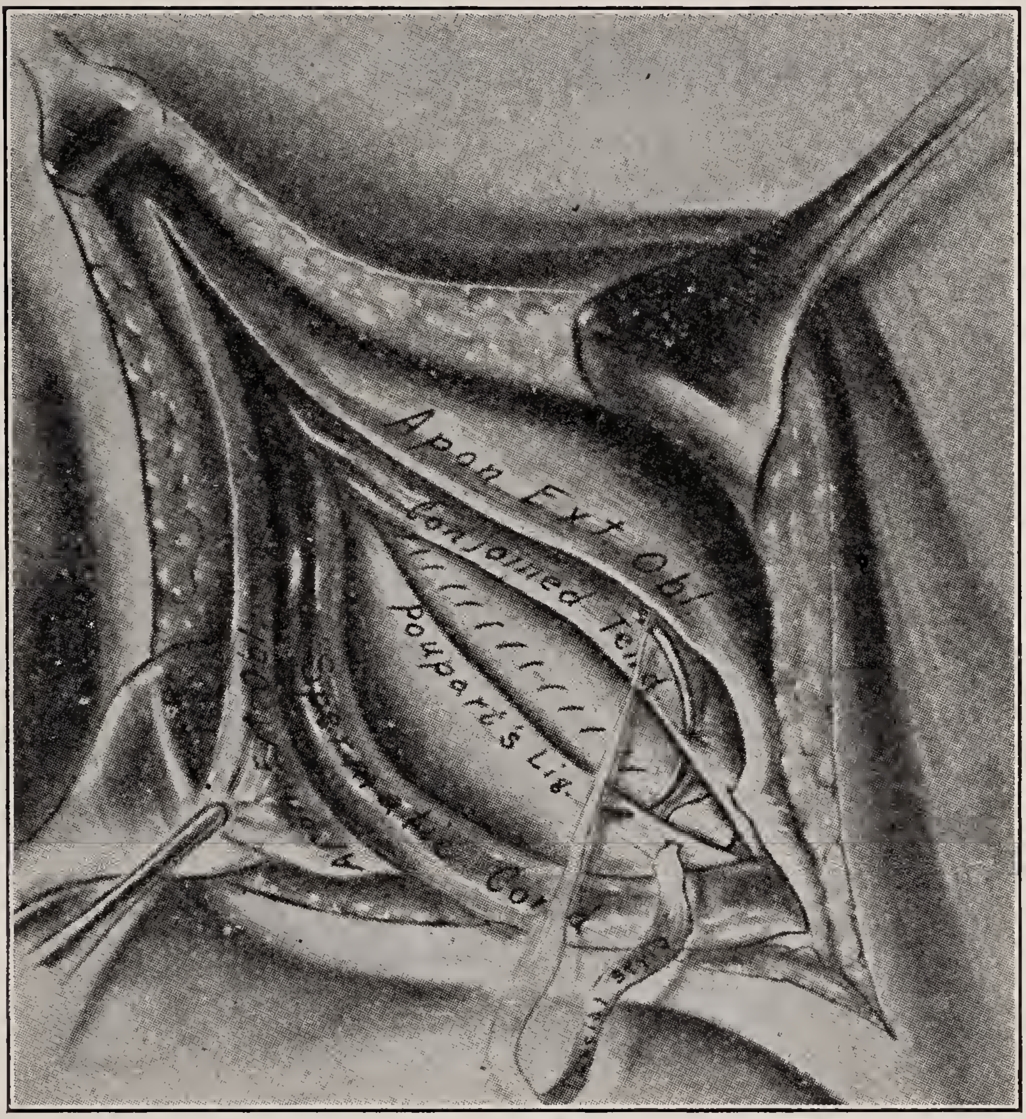

FIG. 28. The transversalis fascia has been reconstructed by suture (chromicized catgut). A pedicled strip of the aponeurosis of the external oblique muscle is outlined by dotted line. (Courtesy of Journal of American Medical Association.)

The fascial sutures are continued up to and around the internal ring, every other one being anchored with an interrupted chromic suture and properly fixed below. The posterior wall now consists of rectus and transversalis fascia to Poupart's ligament; internal oblique and transversalis muscle plus transversalis fascia to Poupart's ligament with the internal ring reinforced with fascial sutures. This is further reinforced by overlapping the external oblique behind the cord with a second continuous fascial suture anchored with chromic as in the first layer. We make no attempt to cover the cord with external oblique aponeurosis but are careful to see that the deep layer of the superficial fascia is properly included in the interrupted skin suture.

McArthur in 1901 advocated cutting a strip of fascia from the mesial leaf of the external oblique. (Figure 28.) The skin incision is longer than for the ordinary hernia so that the fascial flap is cut as long as is possible starting where the edge of the muscle blends into fascia. The strip is about a quarter of an inch wide and widens out at the base which is formed by the internal pillar. (Figure 29.) The fascia is threaded on a special needle and used as a continuous suture to unite the internal oblique and transversalis muscle to Poupart's ligament. A second strip is cut from the outer flap of the external oblique and used to secure the two flaps of the external oblique. Vol. 3. 328.

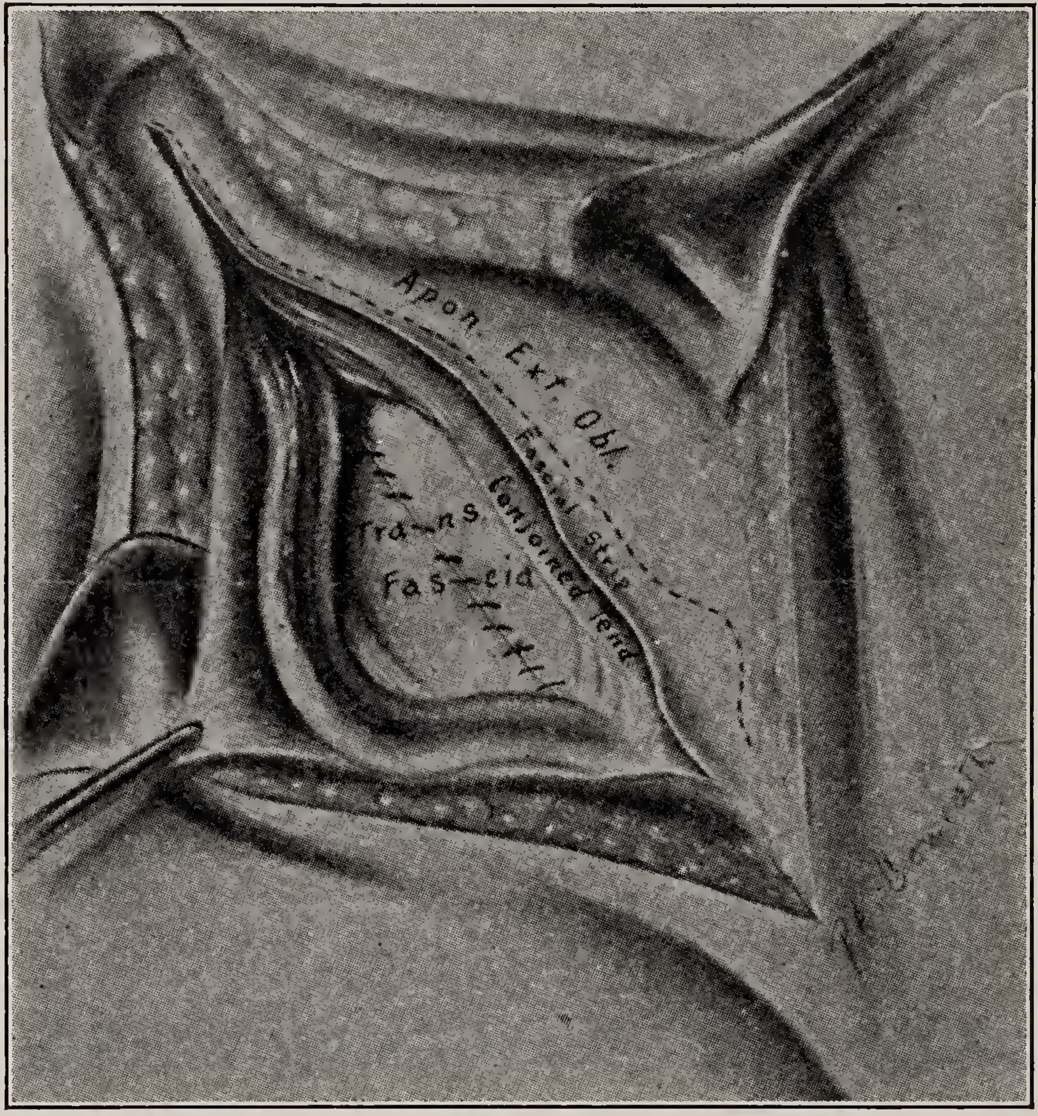

Fig. 29. The fascial strip has been cut and threaded, and is being used to suture conjoined tendon and internal oblique and transversalis muscles of Poupart's ligament. It should be noted that the broad base of the strip serves to support the lower end of the closure, which is ordinarily the weak part. (Courtesy of Journal of American Medical Association.)

SUMMARY OF THE OPERATIVE TREATMENT OF INGUINAL HERNIA

With so many operations and modifications for the radical cure of inguinal hernia, confusion as to what method to adopt may well exist in the minds of many operators.

We have tried to stress the difference between simple indirect hernias, indirects of long standing with large scrotal sacs and direct hernias. Selecting an operation to fit the individual rather than the reverse was never more applicable than in operating on hernias.

Given a narrow necked sac with well developed muscles and a strong transversalis fascia which usually prevails in children and young adults, the Bassini is ideal. Many excellent surgeons of large experience do not advocate transplanting the cord and their results seem satisfactory. With a strong transversalis fascia it probably does not make a great deal of difference whether the cord is transplanted or not as high ligation of the sac is the essential step in the cure.

In many cases the poor musculature and deficient transversalis fascia may not be appreciated until the canal is exposed. In this group the posterior wall must be reinforced or a recurrence is quite probable. Overlapping the external oblique behind the cord according to Wyllys Andrews technique or McArthur's method of fascial suture meet this indication satisfactorily.

Large scrotal hernias with marked deficiency of the posterior wall, we believe after a fairly large experience, are best treated with living fascial sutures by a modified Gallie technique.

Direct hernias cannot be cured except in a small percentage of cases by the simple methods of operating. The posterior wall of the canal must be reinforced with additional tissue. The operations devised by Downes and other advocates of rectus transplantation, overlapping the external oblique behind the cord (Wyllys Andrews) and the McArthur fascial suture are satisfactory in many cases but not all.

Gallie's method of repair with living fascial sutures taken from the thigh, we feel, approaches the ideal. With this method we have ample fascia to build up a firm buttress against recurrence, and, if careful attention is given to the details of the technique failure to effect a cure should be only occasional.

In selecting the operative procedure for the individual case, due attention should also be paid to the occupation of the patient. The more laborious the occupation, the more essential it is that the posterior wall of the canal should be reinforced adequately by one of the modifications of the simpler methods to withstand the added strain thrown upon the repair.

HERNIA OF THE LARGE INTESTINE

Sliding Hernia. When a hernial sac contains a viscus, or portion thereof, which is normally incompletely covered with peritoneum, the condition is said to be a sliding hernia. The circumference of the sac contains at some point visceral peritoneum, instead of being composed entirely of parietal peritoneum as in the case of non-sliding hernia.

Both direct and indirect types of hernia may be complicated by sliding of viscera. In the former the bladder is the organ most often involved. In the latter the large bowel is the commonest finding; on the right side cecum and ascending colon; on the left, sigmoid and descending colon.

The mechanism of the formation of a sliding hernia is best understood by comparing it to a glacier. Sliding along upon the muscles of the posterior abdominal wall the cecum (or descending colon) descends, being pulled by its visceral peritoneal covering, which is also posterior parietal peritoneum. As the sac increases in size more abdominal parietal peritoneum is drawn down as saccular peritoneum. If at the outset the point where the parietal peritoneum is reflected over the viscus is far from the internal ring (or femoral ring) then a slide sufficient to produce gut in the sac will require the growth of the hernia to a large size; if on the other hand it is close to the ring, a sliding hernia may result with a less elongated sac. Therefore, while the majority of sliding hernias of cecum or sigmoid are of large size, some may be only moderate and the possibility should therefore be constantly in the mind of the operator. Clinically, the importance of sliding hernia is threefold:

First, they should be diagnosed whenever possible so that truss treatment, which is generally contra-indicated, will not be attempted, and so that the greater operative difficulties and the prolongation of the time of the operation will not come as a complete surprise, but can be anticipated; moreover, if the condition is suspected, the operator is less likely to injure the gut when opening into the sac.

Second, because the high ligation of the sac, so vital a part of the radical cure, is impossible unless some maneuver is employed to reconstruct a mesentery for the sliding portion of the bowel so as to convert it from an extra-saccular into a wholly intra-saccular viscus.

Third, since a perfect closure of the sac can seldom be attained, the operator should be forewarned so that one of the modifications of the simple methods of repair can be planned to strengthen the inguinal region against the likelihood of a recurrence, which is great after operations for this type of hernia.

Hernia of the sliding type is most common in males between 40 and 60. It occurs far less frequently in femoral hernia than in inguinal. Watson found that in a collected series of 648 cases, 412 were right inguinal, 205 left inguinal; 29 right femoral and 2 left femoral. As to its relative frequency compared to ordinary hernia, Brenner found sliding hernia of the sigmoid 20 times, and of the cecum 39 times in 3000 operations for hernia.

Hernia of the Large Intestine — Not sliding. There are a large proportion of hernias of the colon that are not of the sliding variety — i.e. the cecum, sigmoid or transverse colon may occupy a position in the sac but are freely movable and entirely covered with peritoneum. Unless intra-saccular adhesions of inflammatory nature have been formed, the viscus is readily reducible. The appendix is often present in the sac of right sided hernias when the cecum is present — or it may be contained in the sac without the presence of the cecum. Omentum and small intestine may be present coincidentally. W. B. Coley analyzed 220 cases of hernia, finding cecum alone 18 times, appendix alone 10 times, and cecum and appendix 7 times.

The frequency of large intestine as a content of the sac in newly born and in children is well recognized. Lardennois and Okinczyc stated that 40% of the strangulated hernias in the newly born and 27% of those in children contain large intestine, usually the cecum; while in simple hernias, 3% of those in children, and 6% of those in adults contain a portion of the large intestine.

Large intestine in umbilical and ventral, diaphragmatic, perineal, obturator and sciatic hernias may occur but will be dealt with under their respective headings.

Operative Treatment. The possibility of a sliding hernia must always be borne in mind especially in large hernias in patients past middle life. If the wall of the sac is carefully palpated a thickening may be felt which should always make one suspicious. If large gut is suspected incise the sac on its antero internal aspect, if bladder is feared, on the outer aspect. A scalpel is the safest instrument to use and if considerable bleeding is encountered without entering the sac select another point of entrance. When peritoneum is definitely found usually a fold of it can be rolled on itself which gives one more confidence in selecting the proper site for opening.

The muscular coat of the intestines or bladder can always be recognized if the incision is made cautiously under careful sponging before the mucous membrane of the viscus is opened. Mistakes are usually made by picking up a large bite of sac between two thumb forceps and making a generous incision with scissors.

Large intestine. In right sided hernias we usually have the cecum to deal with and in left sided the sigmoid. Inasmuch as they are only partially covered with peritoneum our problem is to make a new mesentery so that the gut may be reduced within the peritoneal cavity and the sac ligated at the internal ring. This is done by making lateral incisions in the sac on either side of the gut, turning the peritoneum back and suturing the cut edges. This procedure if successful mobilizes the bowel so that it can be reduced and the neck of the sac sutured at the desired level. The stump should be anchored well above the internal ring by passing the suture through the muscle. The hernial repair should be accomplished either by the Wyllys Andrews method or one of its modifications, the McArthur fascial sutures, or if the condition has been strongly suspected before operation living fascial sutures by a modified Gallie technique we feel offer the best chance of a successful cure.

To prevent the gut sliding down again through the internal ring some form of cecopecy or colopexy may be employed. If the internal ring is large this may be accomplished by retracting it upward and suturing the gut to the posterior abdominal wall through it. If this is not practicable a laparotomy incision exposing the iliac fossa may be indicated.

Bladder. This viscus presents a different problem as it is normally more extra- than intra-peritoneal. After stripping the sac from it so that a high ligation can be obtained reduce the bladder behind the transversalis fascia and attempt to keep it there by a satisfactory closure of the posterior wall of the inguinal canal. As the accompanying sac is usually direct the methods applicable for the cure of that type of hernia are indicated.

RECURRENT INGUINAL HERNIA

The problem of the patient who comes for advice regarding a hernia that has recurred following an operation is not always a simple one. There are a number of factors to be taken into consideration before a decision can be reached as to the management of the individual case. Among these factors are: the age, occupation, and economic status of the patient, his general condition, and last, the size of the recurrence as well as its type, and the quality of the tissues that go to make up the inguinal region. None of these points should be overlooked; and the decision can be most judicially arrived at when they have all been carefully weighed.

Inguinal hernia of the oblique or indirect type, if uncomplicated, is susceptible to operative cure in a very large percentage of cases in adults; in children, this should approach one-hundred (100) per cent.

Recurrence in indirect hernia in the adult, barring the very large scrotal, and the sliding type, may be regarded as the result either of an incomplete removal of the original hernia sac, or of failure to properly reconstruct the inguinal canal; especially the transversalis fascia at the site of internal ring, or in the rare case, to a marked deficiency in the muscles of the internal oblique and transversalis and their conjoined tendon, or to wound infection. Hence, measures directed to high ligation of the sac and a properly performed closure of the defective posterior canal wall without tension will reduce the incidence of recurrence to a still smaller ratio than exists at present, regardless of whether a simple Bassini repair, or one of the numerous modifications is done.

Direct hernia, on the other hand, is an altogether different problem. Its origin, age incidence, and attendant anatomical features combine to place it in a distinct class. Moreover, the results of operation by the classical Bassini method are most unsatisfactory. In a series of 280 direct hernias in adult males operated upon prior to May, 1923, at the Hospital for Ruptured and Crippled, by various members of the staff, 85 of which were followed up, there were 14 recurrences, or 16.4 per cent. of those traced. Many of these operations were rectus transpositions, or imbrications of the external oblique aponeurosis. During this period of less than four years, 1155 indirect hernias in adult males were operated upon, of which 332 were traced; showing 28 recurrences, or 8.7 per cent. of the followed cases. It is our belief that direct hernia is more than twice as apt to recur after operation (by any of the methods in common use) than the indirect. Therefore, failure to treat this distinctly different problem in a distinctly different way is one of the important causes of recurrence in inguinal hernia.

Types of recurrences. Recurrences after operation for indirect hernia are noted as direct in type in a majority of cases. Seldom does the recurrence again assume an indirect type and, when it does so, it is usually prima facie evidence of a failure to remove by high ligation all of the original indirect sac. There is, however, a type of recurrence which is seen in cases in which at the first operation the cord has been transplanted so as to lie beneath the skin, generally with an overlapping of the external oblique aponeurosis. The recurrence occurs at the point where the cord emerges straight through the abdominal wall (i.e. at the internal ring). For this variety it is not correct to assume the previous failure to secure a high ligation. Moreover, all direct hernias recur as direct unless at the time of first operation an associated indirect was overlooked, i.e., the saddle-bag type in which only the direct sac was recognized. Cure by a second operation is almost invariably more difficult than would be the case were they primary direct hernias. Moreover, many patients observed have had more than one previous operation. The technical difficulties often increase with the number of previous unsuccessful attempts at surgical cure. Occasionally, there may be two separate and distinct defects along the line of the repair. These are apt to occur in cases that have had more than one operation previously.

The landmarks may be obliterated by dense scar tissue and the structures upon which we rely to effect a closure may be largely replaced by it.

Interval between operation and recurrence. The interval between the primary operation and the onset of recurrence is a variable factor. Watson states (Hernia p. 267) "When recurrence takes place, it usually occurs within the first few weeks after operation." In our experience, the rare instance of a recurrence noted a few weeks after operation is due in most instances to the failure to discover and to properly dispose of a sac that was present at the time of operation. This is most often of the indirect type. Where a direct sac was present but not discovered during the removal of the more obvious indirect sac, the "recurrence" is not, as a rule, noted before two to six months have elapsed, during which time the repair is gradually stretched and pulled away from its anchorage to Poupart's ligament. If the repair is particularly effective, this period of freedom may be extended to a year or more, and, indeed, may depend in no small degree upon the amount of strain that is put upon it by reason of the occupation and habits of the subject. At this point, we believe it worth while calling attention to a point we have not seen emphasized in the literature on hernia, namely, that in those occasional instances where a patient has had an operation years previously for indirect hernia, which has been successful, and later at the age when direct hernia occurs in its greatest frequency, a hernia gradually manifests itself, which at re-operation proves to be direct in type, it is a mistake to term the later hernia a recurrence. The patient simply developed a direct hernia as the result of gradual progressive atrophy, stretching, and fatty infiltration of the muscles of the posterior canal wall at its lower portion; just as such a condition develops in a certain proportion of individuals who have never been, by reason of defective closure of the processus vaginalis, subject to indirect hernia.

Since follow-up examinations of hernia cases have become the accepted procedure upon which to base conclusions as to the results of operation, it is apparent that some standard interval of time is essential. Statistics based upon 52 recurrent hernias observed in a series of 3000 operations at the Ruptured and Crippled Hospital showed that the average elapsed time between the operation and recurrence was 7.1 months. The longest elapsed time was 31 months. A two-year follow-up period seems satisfactory as a routine, although this offers great difficulties in clinics situated in large cities owing to the floating character of the population.

Location of recurrence. In our experience indirect hernia recurs most frequently as a direct sac through the deep suture line at the lower part of the repair, just above the pubis; next most frequently at the point where the cord emerges and less often at some point between, as where one of the sutures has failed to hold. Direct hernia on the other hand recurs through the posterior wall at the external ring and the secondary recurrence is direct in type. The secondary recurrences after operation for recurrent hernia may take place at any point along the course of the inguinal canal, though most often they are found at the lower angle; and it is most difficult, after two or more previous operations have distorted the anatomical landmarks, to accurately classify these secondary recurrences as direct or indirect in type; nor is such a classification here of value. All secondary recurrences should be regarded as difficult operative problems deserving of a special operative procedure, or else operation should not be advised at all.

Symptoms of recurrence. A fair percentage of patients with a recurrence suffer no apparent discomfort. Pain is by no means constant. However, when pain is noted after a lapse of considerable time after operation, during which time patient has been entirely free from discomfort, it is suggestive of a recurrence. The most common symptom is a “ feeling of weakness ” as if “ something had given way ” in the groin. It should be borne in mind, however, that many individuals with a small recurrence, especially of the direct type, may give no symptoms whatever and be unaware of its presence.

Prognosis. This group of hernias represents the most unfavorable class for operative cure of any that we meet. The normal relationship of the anatomical structures has been disturbed. The hernias for the most part are direct in type and the transversalis fascia is defective or lacking. Scar tissue forms a definite obstacle, which must be overcome at the secondary operation. Interference with normal blood supply and enervation of the muscles may play a part in the general weakness of the inguinal region, so that it may even be difficult to secure firm anchorage for the fascial sutures, should they be used.

Treatment. For the individual case, where the decision against operation has been made by the surgeon, or has been reached by the patient himself, the alternative is a truss.

If operation is decided upon, some form of living suture repair is most desirable and, of these, the Gallie method, using strips of fascia-lata from the thigh, is certainly the most effective.

McArthur's method depends upon one or two strips of fascia of the external oblique; and one is, accordingly, limited both in amount and in quality of fascia. Furthermore, unlike the primary operation, one usually finds the external oblique aponeurosis adherent to underlying muscle and to the subcutaneous tissue, and mobilization of satisfactory strips is more difficult.

Again the previous operator may have overlapped the aponeurosis beneath the cord and thus rendered it unavailable as a source for suture material. Gallie's method, however, assures a sufficient supply of suture material, amply strong, with which to close the large defects without tension. It is our belief that no other type of operation can compare with it for the cure of recurrent inguinal hernia. We believe that when statistics on large series of recurrent cases operated upon by this method adequately traced for a two to five year period are forthcoming, the results will justify the superiority of this method over any of the others in common use.

Results. Since first adopting the Gallie procedure as the basis of an operative technique, in February, 1924, we have personally operated upon sixty-one recurrent inguinal hernias in fifty-two patients. Of these, forty-four were direct recurrences and seventeen indirect. There were eight that had recurred twice, two thrice and one four times and one five times previously. During the period from February, 1924 to date, no case of recurrent hernia was refused operation, and many of this series were quite hopeless from the standpoint of cure by any of the classical hernia operations. In some, which had been repeatedly operated upon, the tissue that was present could not possibly have been drawn together to close the defect without extreme tension and with an absolute certainty of failure. In these, the defect was closed under no tension, using the sock-darning method of applying the living sutures and thus bridging the gap.

In our series we have failed to effect a permanent cure in twelve cases under this method. This is due, no doubt, in part to the failure to place the sutures with enough accuracy to prevent protrusion of peritoneum between the meshes. Some defects were so large and so lacking in strong tissue at the circumference (as a result of the previous operations) that a secure anchorage for the weaving of the fascial sutures could not be readily obtained.

It is not unlikely that an appreciable percentage of recurrent hernias will defy any operative method of cure; particularly those in which previous mutiple operations have altered the normal relationships of the inguinal canal or destroyed the integrity of the abdominal layers. In the majority, however, the adoption of the Gallie principle of living suture as a substitute for the customary closure by chromic catgut or kangaroo tendon, with due attention to details of technique, will show results better than those obtainable by other operative methods. Moreover, when direct hernia with its attendant laxity of the transversalis fascia is generally recognized as demanding for its operative cure some method which closes firmly the defect in the abdominal wall by fascial layers either as free fascial graft sutures (Gallie), or pedicled fascial sutures from the external oblique aponeurosis (McArthur), or by overlapping operations utilizing the external oblique flaps as a whole (Wyllys Andrews, Schley, Stetten), rather than by attempts to draw down muscle of internal oblique and transveralis fascia and their conjoined tendon (simple Bassini), or rectus transplant (Bloodgood, Downes), which is invariably done under more or less tension, then recurrences will become less frequent; and in turn the prestige of herniotomy will be further enhanced among the laity as well as among the members of our own profession.

FEMORAL HERNIA

Femoral hernia is much more common in females. In 288 cases in adults at the Hospital for the Ruptured and Crippled, 244 were in females and 44 in males, a proportion of five and a half to one. While this condition is said to be correspondingly rare in children we have operated upon 96 patients under the age of thirteen, a proportion of one child to three adults. Curiously enough there were fifty males and forty-six females.

Berger has pointed out the frequency of inguinal hernia in early life and the comparative rarity of femoral hernia before fifteen years of age. His statistics show that the latter only occurs in one per cent. of all hernias in children. In 6604 operations for hernia in children at the Hospital for the Ruptured and Crippled there were 6508 inguinal hernias and ninety-six femoral hernias, a proportion of 1.4 per cent. of femoral hernias.

Etiology. Authorities are not in accord as regards the etiology of femoral hernia. One of the accepted theories assumes the existence of a congenital diverticulum, or sac, in the femoral opening as a causative factor in all cases. Murray and Russell are independent advocates of this theory, which is, however, bitterly opposed by Sir Arthur Keith, Eccles and others, who contend that femoral hernia is generally acquired rather than congenital. These observers offer as evidence the fact that at no time during development is the femoral canal open to permit the passage of any structure from within the abdomen. Moreover, they call attention to the fact that femoral hernia is not common before the twentieth year, which would scarcely be the case were it of congenital origin. We believe, that while in the majority of instances femoral hernia is an acquired condition, there undoubtedly exists in a considerable percentage of individuals a developmental tendency towards the formation of a femoral hernia and, given favorable factors to enhance its development, a true hernia is the result. Anatomical predisposing factors are the presence of a preformed sac, large ring, lack of fat with a resulting prominence of the peritoneal depression over the femoral ring; other factors that may play a part are pregnancy, emaciation, relaxation of the ring with advancing years, and occupations requiring habitual stooping position.

Anatomy. The anatomy of the femoral region is fully described in anatomical textbooks and only brief reference to it will be made here. The femoral sheath is a conical fascial investment for the femoral vessels as prolonged beneath Poupart's ligament into Scarpa's triangle. Above, it is continuous with the fascia lining the inner surface of the abdominal wall, formed by the fascia transversalis in front and the iliac fascia behind. The sheath is divided into three compartments: an outer space for the artery, a middle space for the vein and an inner channel, which is known as the femoral canal. It is through this canal, from one to two centimeters in length, that the femoral hernia passes to enter the thigh. The upper limit of the femoral canal is the femoral ring, which has the following relationships to adjacent structures. Anteriorly, it is bounded by Poupart's ligament; medially, it is in contact with Gimbernat's ligament; laterally, it is in close apposition to the femoral vein and posteriorly, with Cooper's fascia, covering the horizontal ramus of the os pubis. The femoral ring is separated from the internal abdominal ring by the deep epigastric artery, which lies close to the upper and outer margin of the femoral ring. When the obturator artery springs from the deep epigastric artery, which occurs in about 30% of the subjects, it crosses the upper and inner portions of the femoral ring, where it is readily injured at operation, if the ring is divided, and may give rise to serious hemorrhage. The obliterated hypogastric artery is close to the inner margin of the ring.

The firm, unyielding density of the aponeuroses that surround the femoral ring favors early strangulation. In addition, the sharp, upper edge of the saphenous opening and the abrupt angle made by the sac as it bulges forward upon the thigh after its escape from the saphenous opening combine to intensify the constriction and congestion of the contents of the sac. The femoral canal ends at the saphenous opening, which is covered by cribriform fascia. As the hernial sac descends through the femoral ring, pushing before it the areolar tissue, which normally plugs the canal, it is directed forwards through the saphenous opening.

The coverings of the femoral hernia are peritoneum, extraperitoneal tissue (crural septum), femoral sheath, cribriform fascia, superficial fascia and skin.

Symptoms and diagnosis of Femoral Hernia. The patient complains of a swelling in the groin which may or may not entirely disappear on lying down. Pain is variable. Frequently it is not present and unless the sac contains adherent omentum never severe. A dragging sensation in the region of the hernia may be mentioned as the only symptom.

On examination a globular mass between a hickory and English walnut in size is felt just below Poupart's ligament and external to the spine of the pubis. If larger, the sac may pass up over Poupart's ligament and lie above it on the external oblique but always external to the spine. A considerable amount of properitoneal fat frequently surrounds the sac, and although the latter does not contain any irreducible omentum it may not entirely disappear when an attempt at reduction is made. Inasmuch as the neck of the sac is often very narrow, an impulse on coughing may not be present.

Differential diagnosis. Reducible femoral hernia must be differentiated from inguinal hernia, femoral varix and psoas abscess. The first has been described under inguinal hernia. The possibility of a femoral varix must always be borne in mind in examining a case of suspected femoral hernia. Varicosities of the thigh or leg should always make one suspicious. Both conditions present a globular swelling in the same location which disappears on lying down and reappears on standing or coughing. In a femoral hernia there is an impulse on coughing and in a femoral varix a peculiar thrill which feels very much like an impulse but with the patient standing the thrill is *always* transmitted down along the course of the vein while the impulse is not. This is the chief diagnostic point and if always searched for mistakes in differentiating these two conditions will rarely occur.

When a psoas abscess has descended beneath Poupart's ligament into the thigh it gives an expansile sensation on coughing which may simulate an impulse. The tumor fluctuates and careful palpation of the iliac fossa reveals the same mass above the ligament with fluctuation which can be transmitted between the two. Careful examination of the pubic spine usually reveals its origin.

Irreducible femoral hernia is frequently confused with a femoral adenitis. When only one lymph node is involved their differentiation may be very difficult. If an adenitis is suspected search carefully for a source of infection on the leg or foot as a slight abrasion may explain its origin. A femoral hernia is spherical in shape while there is usually a long axis to the lymph node which extends toward the anterior superior spine. Careful examination will usually reveal a few smaller nodes along this axis. Of course if an impulse is obtained the differential diagnosis is simple. Various tumors such as lipoma, fibroma and lymphocele occurring in this region may be confused with femoral hernia but on careful examination no difficulty should arise in differentiating them.

Treatment of Femoral Hernia — mechanical. This method is only palliative as a truss will not cure a femoral hernia. If a small reducible sac exists a properly fitting truss may give relief but many sacs are surrounded by a considerable amount of properitoneal fat and the mass cannot be entirely reduced. In this type of case a truss causes undue pressure aggravating the condition and consequently is definitely contra-indicated.

Operative. There are two classical approaches to femoral hernia, the femoral and the inguinal.

Femoral route. This method is more common as well as less complicated and gives excellent results. The incision may be vertical, the mid part of it lying over the neck of the sac or oblique lying directly over Poupart's ligament. Our preference is for the latter as we feel the sutures for the closure of the femoral ring can be inserted to better advantage and if an error in diagnosis has been made the subsequent exposure of the inguinal canal is easily accomplished. An incision three inches long terminating at the spine is adequate and as soon as the deep layer of superficial fascia is divided the sac surrounded by properitoneal fat is exposed. These are readily separated from adjacent tissues and the neck identified. By making gentle traction and introducing blunt pointed curved scissors between the sac surrounded by its layer of properitoneal fat and the femoral ring and opening them slightly the adhesions are separated and the neck of the sac pulled down for at least three-quarters of an inch. This is an essential feature of the operation, for without it neither high ligation of the sac or satisfactory closure of the femoral ring can be accomplished.

We are now ready to open the sac. This may be simple but if there is a considerable amount of properitoneal fat which is the rule, rather than the exception, considerable care must be exercised. The possibility of the bladder lying on its inner side must not be forgotten and for this reason the sac should be opened on its outer aspect preferably with a sharp scalpel. Frequently a small strand of adherent omentum presents on opening the sac which must be ligated and reduced or excised. We have the choice of separating the sac from the properitoneal fat and ligating them separately or together. The latter is easier and we believe just as effectual. The transfixion suture is passed well above the original neck and after ligating and excising the sac the stump must retract well within the femoral ring. Probably most femoral hernias with a narrow neck and not too large femoral ring are cured by this procedure.

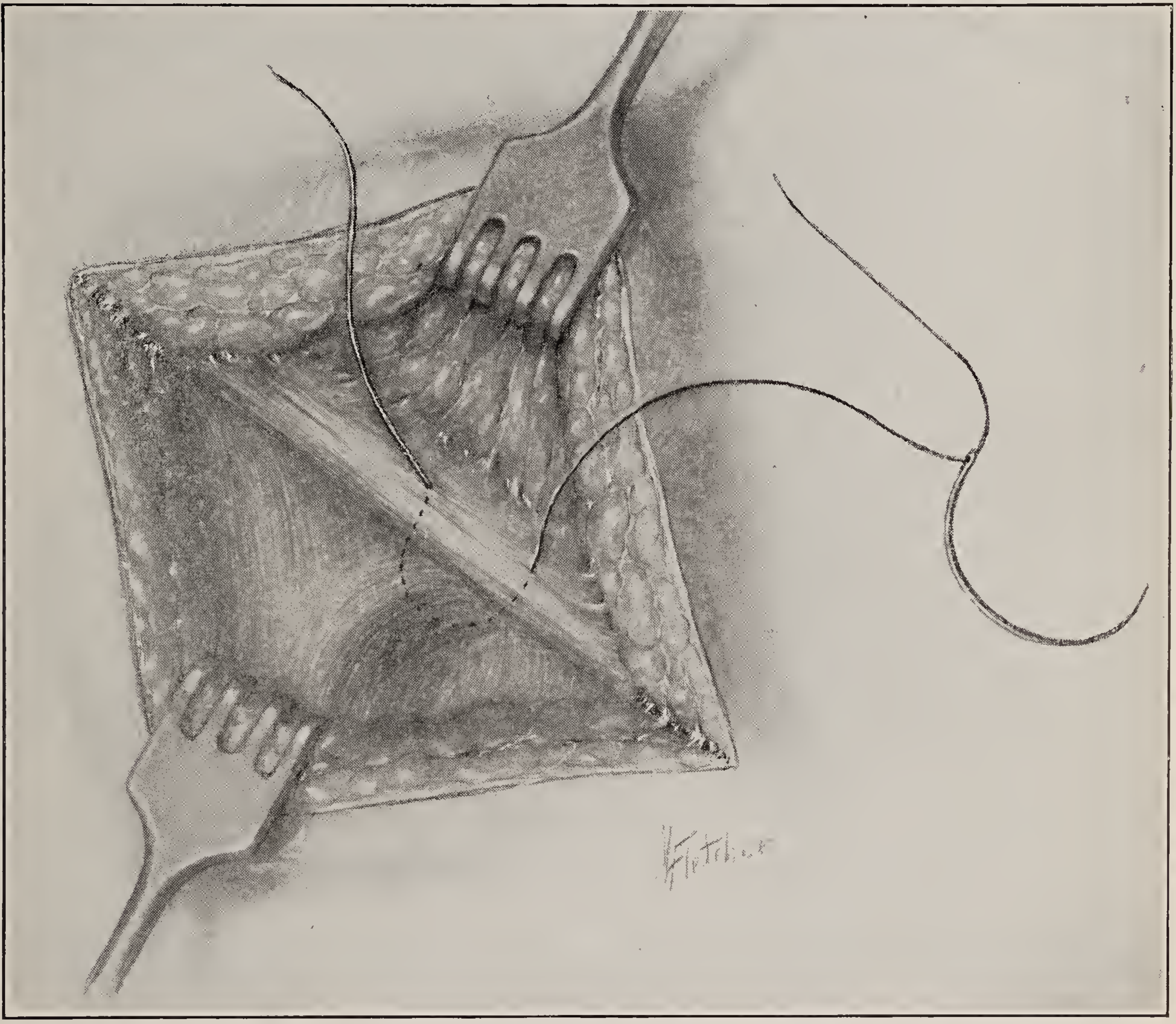

FIG. 30. Closure of femoral ring by mattress suture.

The fascia covering the pectineus muscle is exposed and all extraneous fat removed. We are ready for the next step which is the closure of the femoral ring. Obviously this cannot be completely closed lest the femoral vein be too much constricted. Many methods for closure of the ring have been advocated from simple suturing to anchoring Poupart's ligament to the pubis with a metal staple. Mattress sutures of kangaroo tendon or chromic catgut are probably the most satisfactory. (Figure 30.) The femoral vein is protected by a blunt retractor and the innermost suture inserted first as follows: With forceps passed through the ring as a guide a small full curved needle carries the suture through Poupart's ligament, next a good bite of muscle and fascia directly beneath the ligament is obtained, the direction of the needle being inward away from the vein. Poupart's ligament is again entered from within out three-eighths of an inch internal to the beginning of the mattress suture. The suture is now held taut and if the ring is not sufficiently closed a second or even third may be added. It is important to use a small full curved needle else it will be impossible

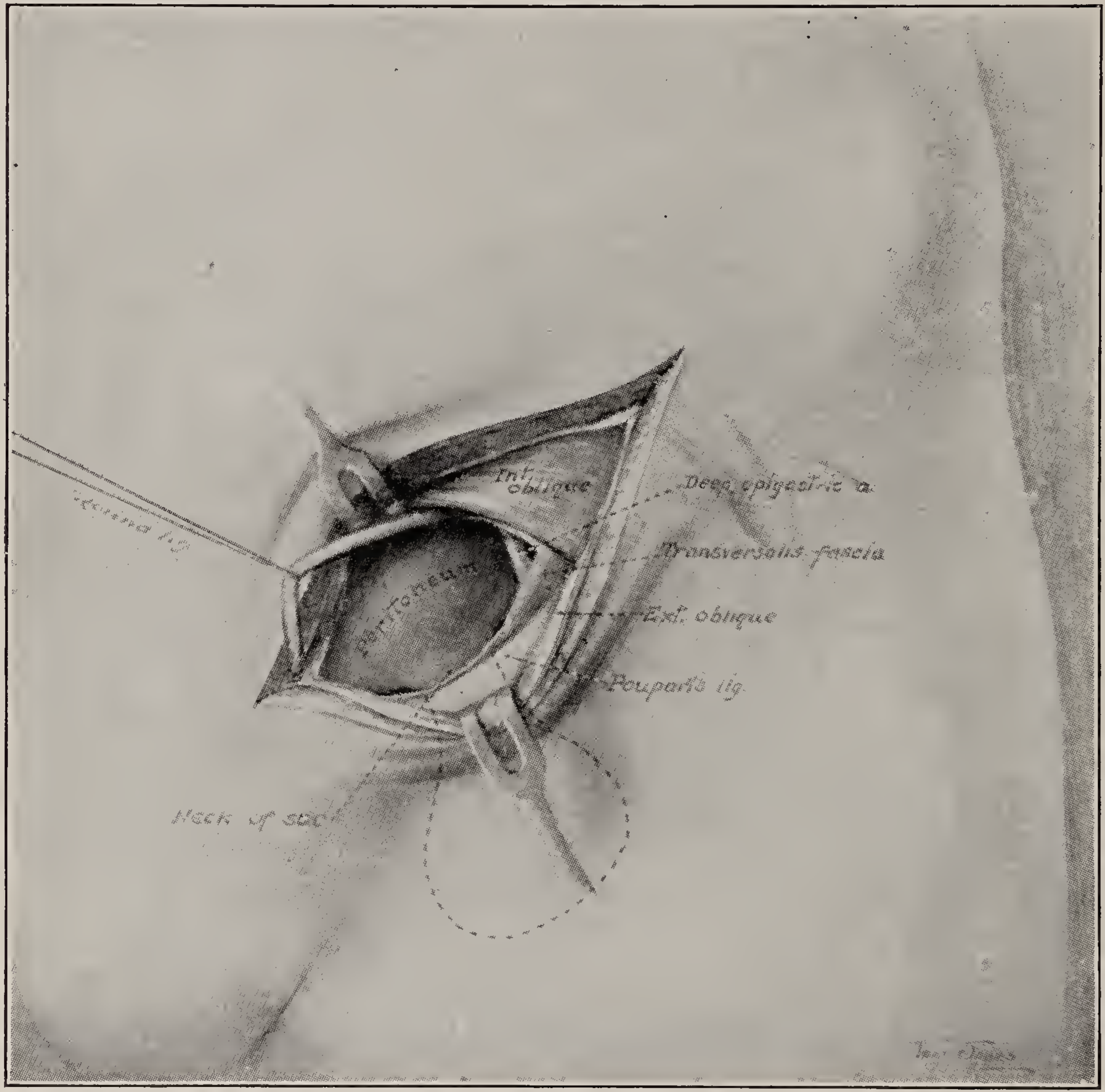

FIG. 31. Skin, Subcutaneous Tissue, External Oblique, and Transversalis Fascia have been incised and the upper and lower flaps retracted upwards and downwards, respectively. (Seelig.)

to pick up the muscle and fascia directly beneath Poupart's ligament, and instead of closing the canal at its base we will close it at its apex. The operation is completed by closing the skin and fascia with a single row of interrupted sutures.

Inguinal route. This method was first described by Annandale in 1876 although many give credit for originality to Lotheissen who described the operation in 1898. Since then numerous writers have discussed and urged that this method take precedent over the older and simpler femoral approach.

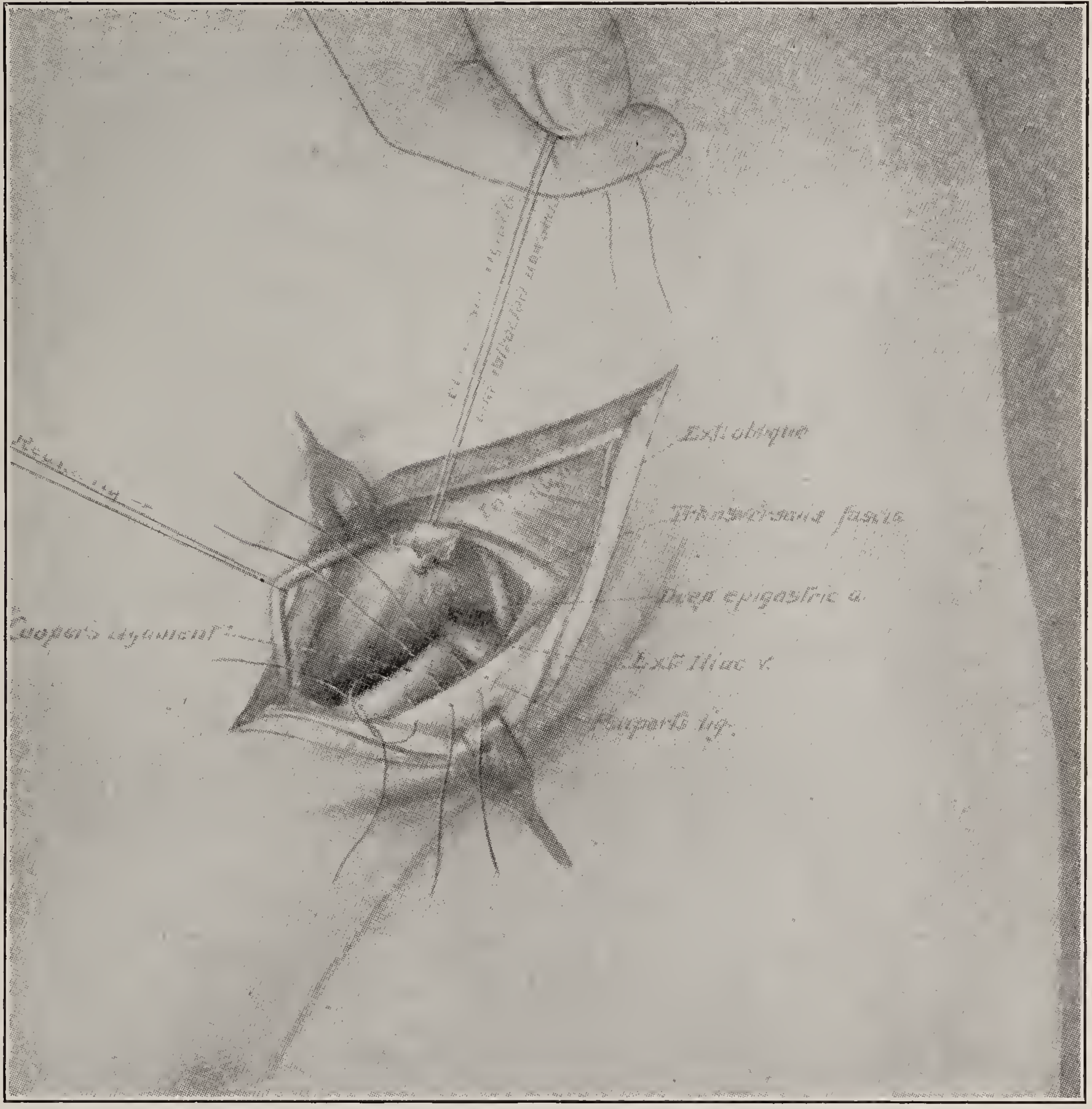

Fig. 32. The Sac has been delivered, ligated high, and amputated. The three chromic gut sutures for closing the femoral ring are in place, ready to tie. (Seelig.)

The skin incision is the same as for an inguinal hernia but carried a little lower over the pubis. On opening the inguinal canal the round ligament or cord is retracted as well as the internal oblique and transversalis muscles and the transversalis fascia exposed. The latter is carefully divided along the line of the incision and with adequate retraction the neck of the hernial sac is exposed passing through the femoral ring. (Figure 31.) If the sac is empty it can usually be pulled up through the ring and ligated at the desired level. If the contents are irreducible but not strangulated gentle traction with pressure from below will usually accomplish reduction. Occasionally the femoral sac must be exposed by enlarging the skin incisions and opening the sac in situ. Any adherent omentum is ligated and excised and the hernia reduced through the ring. Of course if strangulation is suspected the peritoneum must be incised proximal to the neck of the sac and the contents and degree of strangulation noted. This will be referred to again under strangulated femoral hernia.

After the sac has been properly ligated and excised the femoral ring is closed from within. Its boundaries are the external iliac vein (Figure 32) externally, Poupart's ligament anteriorly, Gimbernat's ligament internally and posteriorly, covering the ramus of the pubis, a dense tough fascial membrane known as Cooper's fascia. Interrupted sutures are inserted as follows: The vein is held out of the way and the outermost suture is inserted by passing a small full curved needle between Poupart's ligament and Cooper's fascia. Three or four sutures are sufficient to close the ring, the inner one including Gimbernat's ligament. The remainder of the operation consists in repairing the inguinal canal as in an operation for inguinal hernia. Especial care must be used in properly closing the incision in the transversalis fascia.

Comparison of the two routes. Each has its advantages. The femoral is easier and quicker and for the simple hernia with a narrow necked sac we feel is the method of choice.

In cases of strangulation the inguinal route should be selected as it is very essential to inspect the former contents of the sac after reduction and if resection is indicated it can be carried out under the eye after reduction.

There is a type of femoral hernia which has a broad base corresponding to a direct sac in the inguinal variety. In these cases the femoral ring is much enlarged and ligation of the sac plays a very slight part in the radical cure. This group as well as recurrent femoral hernia should be operated on by the inguinal route and the femoral ring preferably closed by living fascial sutures.

The possibility of a direct inguinal hernia developing after the cure of a femoral hernia through the inguinal canal must always be considered, and if the femoral ring is closed with fascial sutures we advise suturing the transversalis fascia also with living sutures.

THE ANATOMY OF UMBILICAL HERNIA

Umbilical hernia is a protrusion of abdominal viscera through the umbilical ring. This protrusion may take place through an orifice which has failed to close in embryonic life or through an umbilical ring which, though closed at birth, has become open in infancy or adult life.

Hernia in the umbilical cord or congenital hernia of the cord is, strictly speaking, not a hernia because, as pointed out by Malgaigne, the viscera involved have never been occupants of the abdominal cavity. As a matter of fact Ruysch called attention to the fact that in these cases there is no development of the umbilicus, the condition being really eventration. Our knowledge regarding the developmental causes of umbilical hernia is scant and the many theories that have been advanced, though of historic interest, are not of practical value.

In adult life, the umbilicus is three-fourths of an inch above the horizontal line, connecting the highest point of the iliac crests. At two years of age it occupies the exact mid portion of the body, measured from head to foot. In the fetus it is close to the pubis. It represents the final point of closure of the lateral abdominal walls and surrounds the cord vessels which become obliterated at birth. These vessels form four firm, fibrous bands, which pass through the umbilical ring. These four vessels are the vein which descends from above; and the urachus and the hypogastric arteries from below. The urachus holds the umbilicus in firm contact with the lower margin of the ring. The umbilical ring, situated in the linea alba, should normally closely surround the layers of the cord where they have sloughed off. The peritoneum in this region is thin and firmly adherent, particularly above the umbilicus. The transversalis fascia, fortified by fibers known as the umbilical fascia, lie beneath the linea alba. Defects in the normal closure of the umbilical ring may range from a large cleft in the muscular wall, or so-called congenital umbilical hernia, to a slight weakness in this region. The most frequent site for the defect is at the upper margin of the umbilicus. The presence of properitoneal fat in this location undoubtedly plays a part in the formation of umbilical hernia in adult life. In infancy, frequent repetition of sudden increases in intra-abdominal pressure, such as whooping cough, constipation and crying are causes to which the occurrence of umbilical hernia is attributed. The opening in these cases is forced between the vein and the upper margin of the ring where the umbilical scar tissue is the weakest. They are common from six months up to three years. After three years umbilical hernia is rare until early adult life. Umbilical hernia in adults, when small and occurring in obese subjects, is often not noticed by the patient and very frequently overlooked by the casual examiner. The formation of the hernia in the adult is very irregular and influenced not only by the contents of the sac but by the bands encountered while passing through the umbilical ring. Sometimes these bands, the remnants of the umbilical vessels, may divide the tumor into several parts with a resulting lobulated appearance. The coverings of the umbilical hernia are skin, superficial and deep fascia, and peritoneum. The layers of the fascia tend to become markedly thinned out and indistinguishable and the contact between them and the overlying skin is likewise intimate. Since the contents of the sac are often adherent to the peritoneum, the chances of injuring the intestine through an incision directly over the sac should be realized. The contents of the sac vary with the size of the orifice. Omentum is almost universally the first to protrude and readily becomes adherent. Transverse colon and small intestine are often found in umbilical hernias of large size.

Hernia of the Umbilical Cord. A tumor is present in the umbilical region of varying size and of a greenish gray color due to its amniotic covering. Intestines and frequently liver can be palpated through its thin wall and sometimes most of the contents of a normal abdomen are present in the sac.

Treatment consists of immediate operation, the success of which depends on the volume of contents of the sac and whether reduction with but slight increase in intra-abdominal tension is possible. Cases in which most of the liver presents in the sac are usually hopeless.

An incision is made through the skin about the neck of the sac, the fascia incised vertically and the peritoneum opened. After reduction the peritoneum should be closed as a separate layer if the baby's condition permits. The time element is of paramount importance and usually it is better judgment to close the wound with through and through sutures of all the layers.

The infantile form of umbilical hernia. This is a common variety due to a yielding of the umbilical scar from crying, coughing, vomiting, etc. It may not be noticed for several weeks after birth when a small swelling in the region of the umbilicus, increasing in size on any intra-abdominal strain, makes the diagnosis positive. On palpation a ring of fibrous tissue is definitely felt after reduction of the hernia.

Treatment. Some of these hernias are cured spontaneously. For many years at the Ruptured and Crippled Hospital we have treated these cases with a wooden button-mould covered with adhesive plaster and held in place with a two inch strip of adhesive which encircles the abdomen at the level of the umbilicus and overlaps for a distance of at least two

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inches. This form of treatment is successful in the vast majority of cases, but if after several years conservative treatment is ineffectual, or the hernia is fairly large (pigeon egg) we advise operation.

The technique is simple. A vertical incision excising the umbilicus is carried down through the fascia. The neck of the hernia is incised and, if a small strip of omentum protrudes is reduced or ligated and excised. The peritoneum is closed as a separate layer and the fascia overlapped for a distance of one-quarter inch with mattress sutures. The overlapped flap is sutured to the rectus sheath with a continuous suture. Separation of the peritoneum so that it may be closed separately may be difficult, but we feel the step is a very essential one.

A transverse incision with horizontal overlapping is not recommended in children as the recti are in close approximation and overlapping of the fascia between them is not feasible.

The umbilicus may be preserved for cosmetic reasons but we have never felt this essential.

Umbilical hernia in the adult. This type of hernia is much more frequent in females. In 160 operations for umbilical hernia in adults at the Ruptured and Crippled Hospital nearly 90 per cent. were in women. Increasing obesity, multiple pregnancies and lack of proper exercises are important factors in its production. When small these hernias are usually reducible and may be retained by a well-fitting belt. If of long duration they are more apt to contain irreducible omentum and a belt is of no value in retaining the hernia. In fact it may do actual harm, but some relief may be experienced due to the support of an accompanying pendulous abdomen. There is no form of mechanical support that will cure the rupture and it usually keeps on increasing in size.

With the gradual increase in size of the hernia and corresponding increase in subcutaneous abdominal fat digestive disturbances are common. The contents of the sac are usually adherent omentum with large and small intestines. With the increase of adhesions subacute or chronic attacks of obstruction may develop and are more common than acute obstruction.

Irritation of the skin of the hernia when it comes in contact with the skin of the abdomen is frequent and if a belt is persistently worn ulceration of the skin over the sac may occur. These patients are not ideal risks for surgery but operation alone offers relief.

There is no group of surgical cases where corelation of time of operation, pre-operative and post-operative care and anesthesia are more important than in large irreducible umbilical hernias.

Judgment as to the operability of a given case cannot be reached until the patient has been kept in bed on a light or liquid diet with free catharsis for at least a week. Many large hernias with proper support will reduce enormously in size and it is easy to decide whether the remainder of the contents of the sac can be returned to the abdominal cavity without increasing intra-abdominal tension beyond the safety limit. All irritation and ulceration of the skin must be allowed to heal.

Ethylene, or gas and oxygen administered by a competent anesthetist are the anesthetics of choice. Local anesthesia may be employed and should be in strangulated cases if general condition is poor, but a large incision is required and the operation is of necessity much longer under local anesthesia.

Post-operative care to prevent pulmonary congestion is of the utmost importance. Elevation of the head of the bed with the patient nearly upright after recovery from the anesthetic, with frequent turning from side to side will usually prevent this complication.

Operation. Grasp the skin on either side of the hernia with Kocher clamps. These serve as a guide for the length of the incision and fix the skin so that cutting with the scalpel is facilitated. An eliptical transverse incision is made above and below the hernia including nearly all the skin overlying the sac, the incisions meeting at a point corresponding to the outer borders of the recti muscles. (Figure 33.) With an assistant holding the clamps taut the fascia is exposed well away from the hernia. Care must be taken that the sac does not lie in the course of the incision and be accidentally opened. Hemorrhage from subcutaneous vessels is controlled by gauze packing. This eliminates the additional time required for clamping and ligating and is just as effectual. As soon as the fascia is reached the blade of the scalpel is held nearly parallel to the fascia and the subcutaneous fat rapidly dissected away until the neck of the sac is entirely exposed. Vessels which penetrate the fascia are best secured with a ligature threaded on a curved needle. We are now ready to open the neck of the sac. Select a site where no gut or omentum seems adherent and incise with a scalpel. If the latter is sharp and the assistant sponges carefully intestine, if present, can usually be recognized. After the sac is opened pass the fingers around the circumference of the neck and ascertain what adhesions are present.

The technical difficulties in operating on these hernias depend more on the number of adhesions than the size of the hernia. If adhesions are present they must be clamped, divided and ligated until the neck of the sac has been cut across.

The fundus of the sac is now opened and everted and if omentum or intestine is adherent must be appropriately treated. Omentum can be ligated and excised or reduced, the latter being the method of choice if possible. Adhesions of sac to intestine may be separated with the fingers

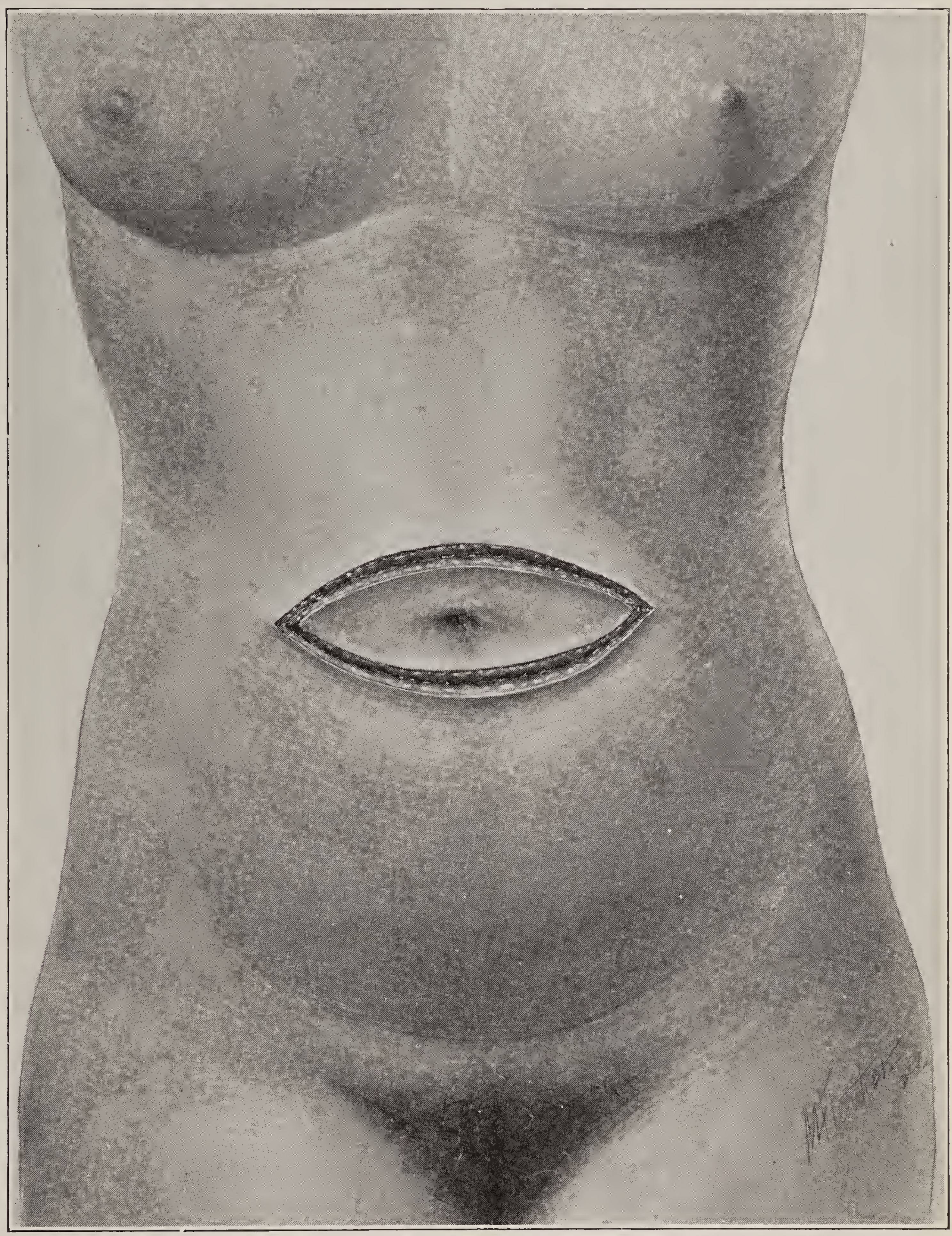

FIG. 33. Skin incision.

if not too dense, but if the sac is firmly adherent, rather than run the risk of opening the bowel it is better judgment to excise a portion of the sac, leaving it attached to the wall of the gut. Raw edges can be sutured so that we need not fear additional intra-abdominal adhesions. If large intestine is present in the sac care must be taken that its mesentery is not mistaken for omentum and its blood supply damaged by careless ligation. The sac, skin and subcutaneous tissue between the eliptical incisions is now removed in one mass.

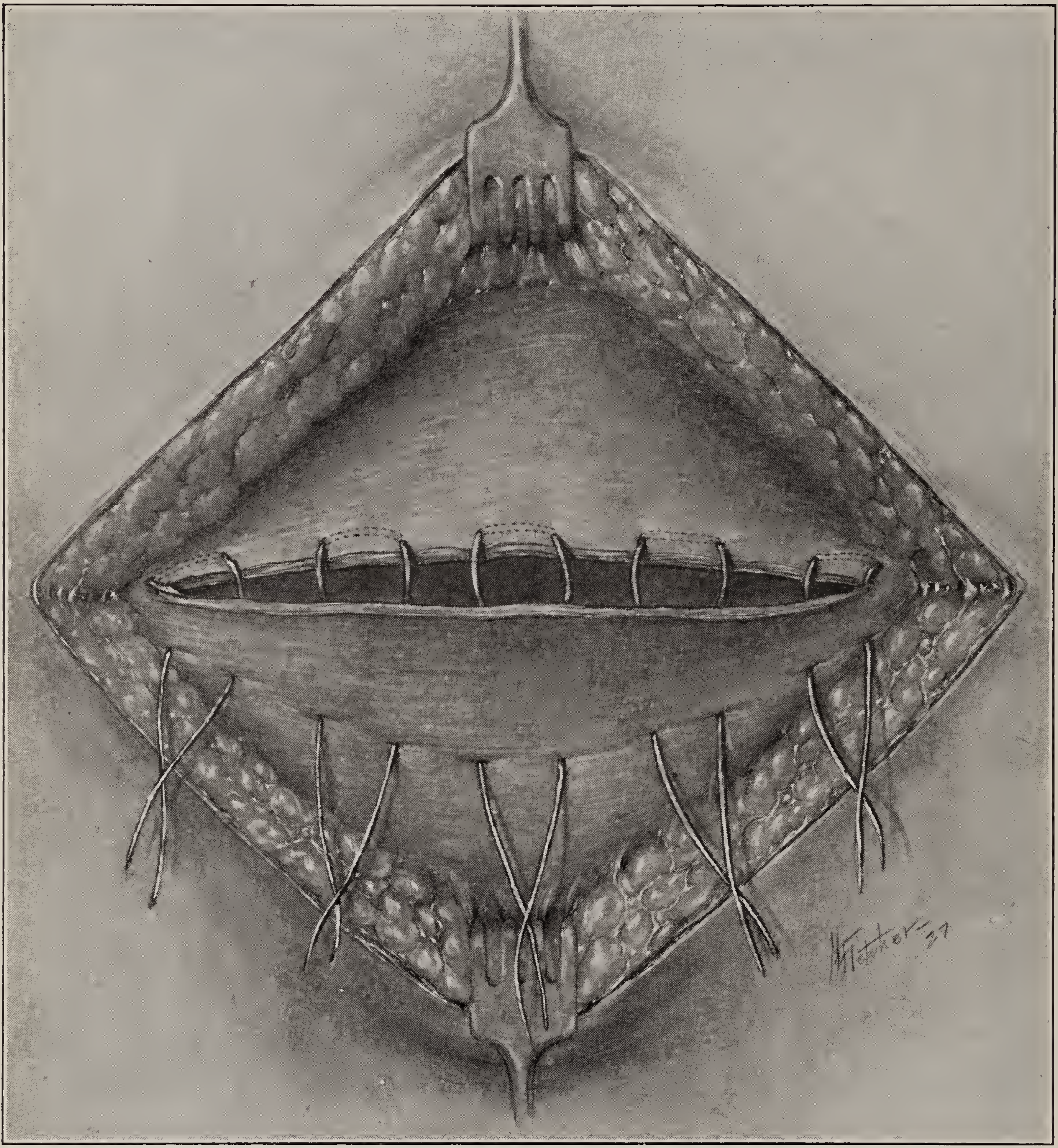

Fig. 34. Mattress sutures inserted.

While the peritoneum is adherent to the overlying fascia an effort must be made to separate the two so that the former may be closed as a separate layer with chromic catgut interrupted at frequent intervals.

The opening in the fascia should be enlarged by transverse incisions until the bellies of the recti are exposed. We are now ready for the overlapping. This can be done from above downwards or below upwards depending upon which fascial flap has been more thoroughly cleared of subcutaneous fat so that the flap which slides posteriorly has no fat intervening between it and the fascial layer to which it is approximated.

We overlap the fascia as much as possible, care being taken that the tissues are not sutured under tension. The average case is overlapped between one and two inches.

Assuming that we are to overlap from below upwards the sutures are inserted as follows. The lower flap is held up and a mattress suture passes through it from without in one to two inches from its free border. Next a good bite about one half inch in width of the free edge of the upper flap is obtained, the needle entering from without in and emerging from within out. (Figure 34.) The suture is completed by passing through the lower flap from within out. The first suture is usually inserted in the middle of the flap and sufficient additional ones are passed on either side to obtain a good closure. The weakest part is at either angle and to reinforce this extend the incision in the anterior sheath of each rectus so that it may be overlapped in front of the belly of the muscle so that the latter forms an additional buttress.

All the mattress sutures are now held taut, the upper flap sliding down under the lower flap and the sutures successively tied. To prevent the escape of abdominal contents between the sutures, the interstices are closed with a continuous suture. (Figure 35.) We now have a redundant flap from the lower layer which is sutured to the upper layer with a few mattress sutures and the free edge approximated with a continuous suture. (Figure 36.)

Rubber dam drainage tubes are inserted at either angle and the wound closed with a few deep interrupted sutures and the skin approximated with either additional interrupted or continuous sutures.

The dressing is firmly fixed with broad strips of adhesive plaster which nearly encircle the waist of the patient.

The drains are removed in forty-eight hours and the patient should remain in bed for fourteen to eighteen days.

As these patients usually possess an excess of fat with a pendulous abdomen they should wear a well fitting belt after the operation. This probably does not aid much in preventing a recurrence but adds greatly to their comfort.

Mayo's operation is similar to the above except that they do not suture the peritoneum as a separate layer. We feel that the union obtained between a peritoneal and fascial surface is not as strong as when two fascial surfaces are opposed without any peritoneum intervening.

A vertical incision with lateral overlapping in a similar manner was described by Blake and is known as his operation. Others have advocated this same principle but it is not used extensively and does not seem as satisfactory as the transverse overlapping.

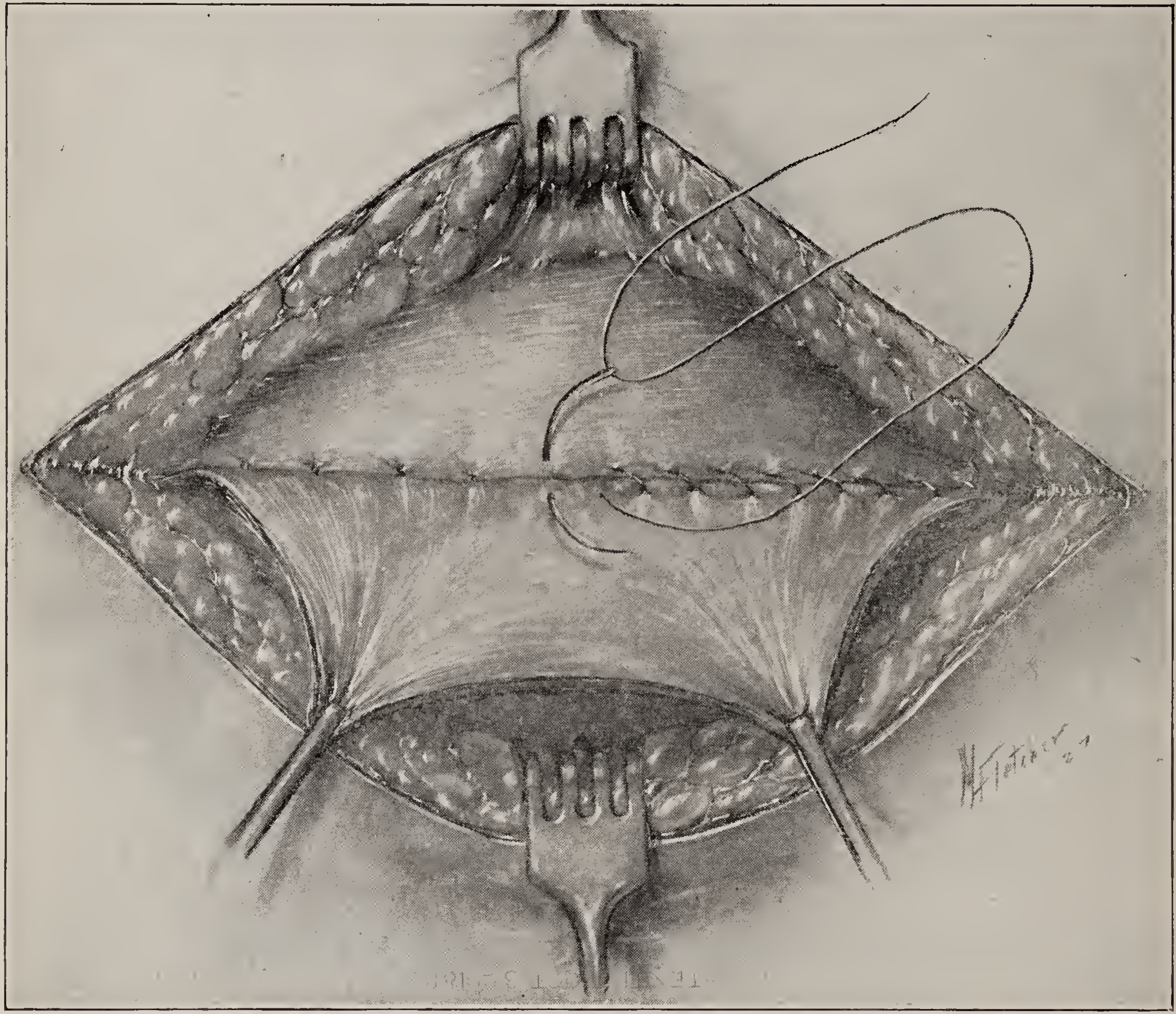

Fig. 35. Continuous suture closing the interstices between the mattress sutures.

Some surgeons use a silver filigree to close large defects and occasionally brilliant results are reported in individual cases but it has never been extensively adopted.

Living fascial sutures were recommended by Gallie and we are inclined to adopt this method as routine in umbilical hernias of large sizes if not all. After suturing the peritoneum we do not attempt to overlap the fascia but secure a large bite from each flap in a continuous fascial suture. Each suture is anchored with an interrupted chromic to relieve the tension on the living suture while union is taking place. A second row of fascial sutures is placed over the first getting a generous bite of fascia one half to one inch distance from the first row. This method is of especial value in large defects when there is not enough tissue available for overlapping. In recurrent umbilical hernias we would not think of using any other method.

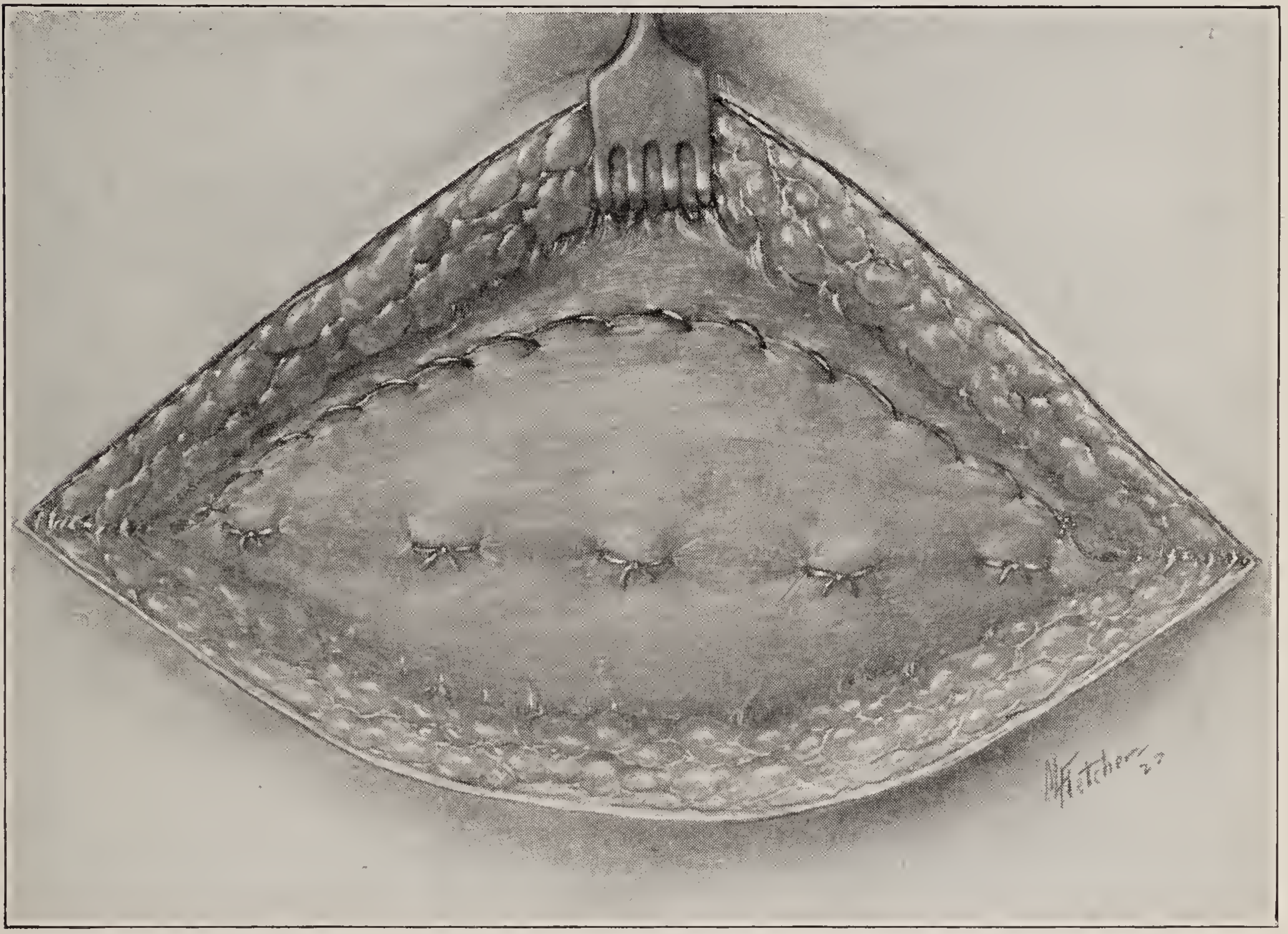

Fig. 36. Free edge of lower flap approximated to upper layer with continuous sutures. The mattress sutures in the redundant flap are not indicated.

VENTRAL HERNIA

The term ventral hernia may be defined as a protrusion through the anterior abdominal wall, occurring at points other than the umbilical, femoral or inguinal openings. This hernia may be divided into two varieties, the acquired, which is incisional or traumatic in origin, and the spontaneous. The spontaneous type occurs in the linea alba (epigastric), in the linea semilunaris and in the linea transversa.

EPIGASTRIC HERNIA (Hernia in the Linea Alba)

Anatomy. The linea alba is a tendinous raphé which extends along the midline of the abdominal wall from ensiform to the symphysis pubis. Situated between the inner borders of the recti muscles, it is formed by the fusion of the aponeuroses of the external and internal oblique and transversalis muscles. In its upper portion it is attached to the falciform ligament of the liver, whose free border contains the round ligament of the liver which runs from its anterior border to the umbilicus.

There are small openings in the linea alba for the passage of tiny perforating bloodvessels which carry with them a prolongation of the transversalis fascia as they traverse this layer; thus a potential weak spot exists at these points. With increased tension within the abdomen, properitoneal fat may be forced alongside the vessel.

The hernial ring or orifice is often no more than one-quarter to one-half inch in diameter. Owing to the fact that the linea alba becomes progressively thinner and broader above the umbilicus, it is in this region that this variety of hernia is most often seen, and hence it derives its name, epigastric hernia. It occurs most commonly in the first three or four inches above the umbilicus, far less often in the first two inches below that structure. A true peritoneal sac is present in less than half the cases. The usual findings are a mass of adipose tissue, which is extruded between the layers of the falciform ligament of the liver. Anteriorly, this adipose tissue is in close relationship with the transversalis fascia at the linea alba, so that given a hiatus in this fascia — caused by a perforating blood vessel — it is obvious that the properitoneal fat in the falciform ligament would be the first tissue to be forced through the opening. The firm, unyielding character of the fascia surrounding these orifices explains the infrequency with which these hernias are found to attain a large size. The presence of a sac may not be recognized in those cases in which it does occur until the overlying fat has been cleared away.

Hernia in the linea alba is five times more frequent in men than in women. It constitutes less than one per cent. of all types of hernia. In the Ruptured and Crippled series of 10,000 hernias, there were 33 of the epigastric variety. They are not infrequently found in association with other hernias. That they are more common than statistics would indicate seems probable, as many cause no symptoms whatsoever and patients are frequently quite unaware of their presence. If small, they are readily overlooked in routine physical examinations. Strangulation is rare, as the neck remains too small in the vast majority of cases to permit of the passage of intestine or even omentum. Moschowitz, in 1914, collected data on only 10 cases of strangulation and added another personal case. He believed from a critique of the original articles that only two of the 10 cases were valid.

HERNIA IN THE LINEA SEMILUNARIS

The lineae semilunares are two longitudinal tendinous lines which run from the cartileges of the ninth ribs to the spines of the os pubis; they correspond to the outer border of the recti and are formed by the aponeurosis of the internal oblique muscle at the point where it splits to enclose the rectus muscle. In its upper three-fourths this aponeurosis is fortified by the external oblique in front and the transversalis behind. At the juncture of the lower fourth with the upper three-fourths the posterior rectus sheath ends in a curved margin, the semilunar fold of Douglas. Below this point the aponeuroses of all three of the flat abdominal muscles pass in front of the rectus to form its anterior sheath. Most of the hernias in the linea semilunaris occur close to the os pubis and are generally classified as direct hernias, though differing from true direct hernias anatomically, and resembling much more closely the hernias through the linea alba. They appear between the edge of the rectus and the deep epigastric artery. Their presence, unless suspected before operation, is readily overlooked during the operative procedure. The small orifice is not readily palpable and the sac itself may be well covered and obscured by a layer of adipose tissue.

Those occurring higher up are generally found at the semilunar fold of Douglas, a potentially weak spot owing to the deficiency of the posterior rectus sheath. The inner third of a line drawn from anterior superior iliac spine to umbilicus marks the location on the surface topography. When small, these swellings are interstitial, difficult to outline, and deeply placed, but as they increase in size they become subcutaneous and are made out more readily under the thinned-out layers of the abdominal wall. The sac is globular or pear-shaped, often covered with properitoneal fat, and frequently is exceedingly thin and friable. The cause of these hernias is still a disputed question. Cooper maintained that they originated through a tiny vascular foramen, much as do those in the linea alba. Barthelmy and Mollière stated that they were the result of the arrangement of the fascial layers in relation to the rectus muscle. Barthelmy collected 23 cases from the literature, all of which gave a history of sudden onset following a strain. Vol. 3. 328.

TREATMENT OF EPIGASTRIC AND SEMILUNARIS HERNIA

The treatment of these hernias is always surgical, for no type of belt or other retentive apparatus is effective. In those cases where the presence of the swelling is noted only in the course of a routine examination and where it causes no discomfort, it is not necessary to urge operation. Due attention, however, should be paid to the possibility of its being the cause of vague digestive complaints. The operative treatment consists in excision of the fatty tumor, where no true sac exists, and closure of the opening in the fascia by transverse overlapping of the flaps made by the vertical incision, the operation being extraperitoneal. Should a true peritoneal sac exist, it should be exposed and opened, contents reduced, adhesions freed, and the edges of the sac closed. Overlapping of the fascia as a separate layer can then be performed.

We feel that the use of living fascial sutures is indicated in these types of hernia, for they are prone to recur and, when recurrence has taken place, they are indeed difficult to cure by secondary operations. The technique of the fascial sutures as described for post-operative ventral hernias or umbilical hernias is applicable to the epigastric type while that described for inguinal hernia is applicable to hernia through the linea semilunaris.

VENTRAL HERNIA FOLLOWING LAPAROTOMY (INCISIONAL HERNIA)

These are most common following a drained laparotomy wound, either from a suppurative appendicitis or purulent infection of the pelvic organs, less frequently from some suppurative condition in the upper abdomen which has required drainage or a mid line incision which has refused to heal per primam.

Ventral hernias following incisions healing by first intention are usually either due to faulty technique in properly suturing the wound or in using faulty material. Both of these faults are largely preventable.

Pathology. The sac is very thin and usually adherent to the skin. After passing through the opening in the musculature of the abdominal wall the sac may extend in any direction and the major part of the hernia lie some distance from the original incision. Adhesions are numerous due to the previous inflammatory condition for which the former operation was performed, and the omentum is apt to be adherent and irreducible especially about the neck of the sac. Either large or small bowel or both may also be adherent and irreducible and loops of small intestine matted together are not uncommon.

Symptoms. The symptoms may be most pronounced in small hernias with narrow necks. We have seen enormous sacs with contents that represented a considerable proportion of the abdominal viscera, yet with relatively few symptoms. The diagnosis is not difficult save in the occasional case with a small interstitial type of sac. If incarcerated, operation alone will positively establish the exact site of the hernial opening.

Treatment. Prophylactic — Proper closure of the incision, keeping the patient in bed a sufficient length of time and mechanical support of drained and large clean wounds for some months after operation all aid in the prevention of this condition.

Mechanical. After a ventral hernia has developed mechanical treatment is of little value; of course it will never effect a cure and as a large number of these hernias soon contain irreducible omentum they usually keep on increasing in size in spite of any mechanical support.

Operative. In large ventral hernias the same pre-operative treatment should be carried out as described for large umbilical hernias.

Hernia following appendectomy. Grasp the skin at either end of the scar of the former incision with Kocher clamps and make an eliptical incision about it, care being taken to have the incision well outside the adherence of the sac to the skin. After cutting through the subcutaneous fat a variable distance the sac is recognized and readily separated from the subcutaneous tissues until the aponeurosis of the external oblique is exposed. This muscle is incised in the direction of its fibers, well away from the neck of the sac in normal tissue and cut away from the neck on either side with scissors. We can now usually decide whether the previous incision has been muscle splitting or through and through. If the former an attempt should be made to divide the internal oblique and transversalis muscles in the direction of their fibers. During this procedure the neck of the sac may have been accidentally opened and if not should be incised now. Unusual care must be taken not to incise the bowel. A loop of gut is very apt to be adherent at this point but by incising with a sharp scalpel under careful sponging this complication is usually avoided. An intestinal suture must always be ready for immediate closure in case this accident does occur. After the neck has been incised at one point the fundus of the sac should be opened and its contents inspected. We can determine the number of adhesions present and by sweeping the finger around the neck of the sac ligate and cut each adhesion as we come to it. The difficulties of the operation depend more on the number and density of the adhesions rather than the size of the hernia.

If loops of intestine are matted together it may be better judgment to reduce the entire loop rather than attempt to separate all the adhesions. Recent ones may be pinched apart with the fingers, but if very dense the danger of entering the bowel or the subsequent formation of fresh adhesions from the numerous raw surfaces may be more serious than the possibility of subsequent obstruction if they are let alone. If a portion of the gut is densely adherent to the sac it is wise to excise a portion of the latter leaving it adherent to the gut and suture over the raw surface. Adherent omentum may be ligated and excised but we feel it wiser to preserve all that can be easily reduced.

After the adhesions have been separated and the hernia reduced the peritoneum and transversalis fascia are sutured if possible as a separate layer with chromic catgut. The muscles are overlapped by a technique similar to that used in the cure of umbilical hernia, the internal oblique and transversalis form the first layers and the external oblique the second. If possible each layer is overlapped in the direction of its fibers.

Ventral hernias in the mid line are treated in a similar manner but when it comes to suturing after closing the peritoneum and transversalis fascia as a separate layer we only have the aponeurosis between the recti to overlap. If the hernial orifice is just above the symphysis pubis a satisfactory closure is very difficult.

Many advocate including the peritoneum in the flap to be overlapped and not attempting to suture it separately. We believe this is a mistake and feel that it is impossible to get as firm union between the fascial flaps if peritoneum intervenes.

If the abdomen is pendulous a belt should be advised and may be worn after an operation for ventral hernia but should not be necessary after the first few months.

The results with chromic or kangaroo tendon as suture material have not been especially encouraging in our experience and we have had much more satisfaction with living fascial sutures. An assistant removes the fascia while the hernia is being prepared for suturing so no additional time is required. The steps are the same up to closure of the muscle. Instead of overlapping the muscular layer the edges are approximated with continuous fascial sutures, every other one being anchored with an interrupted chromic. If there is only one layer of muscle or fascia to approximate as in mid line hernia a second row of sutures is placed over the first. Very large defects can be closed by this method and if it is impossible to approximate the edges without too much tension the fascial sutures can be woven between the two very much as one would darn a sock.

INTERPARIETAL OR INTERSTITIAL HERNIA

There are three varieties of this type of hernia — i.e., properitoneal, interstitial and inguino-superficial. They occur more frequently in oblique inguinal hernias and are found oftener in male subjects.

Properitoneal hernia is characterized by a burrowing of the sac between the peritoneum and transversalis fascia; the opening, or neck of the sac, is at the internal ring.

In interstitial, or intermuscular hernia, the sac may burrow either (*a*) between the transversalis muscle and fascia, (*b*) between the fibers of the internal oblique muscle, (*c*) between the internal oblique and the external oblique muscles or (*d*) between transversalis fascia and the external oblique muscle or aponeurosis.

These hernias, especially the inguino-superficial type, are often seen in association with mal descent of the testis and bilocular sacs are by no means rare. The loculi communicate at or near the internal ring by a common opening; one loculus is usually headed toward the scrotum; the other, often empty, lies between the layers of the abdominal wall extending toward the anterior superior iliac spine.

Moschowitz in 1903 was able to collect only 17 cases of inguino-superficial hernia from the literature; however, we found 73 cases in a survey of 537 cases of abnormal descent of the testis from the records of a single hospital.

Treatment consists in recognition of the anomalous position of the sac and complete extirpation with overlapping of the muscle planes. When inguino-superficial hernia is suspected great care should be taken to avoid damage to the testis in making the incision through the skin. When anomalies of position of the testis are met these should be recognized and an effort made to place this organ in its natural position in the scrotum. Bilocular sacs should be looked for and both removed to insure against a " recurrence."

DIAPHRAGMATIC HERNIA

A diaphragmatic hernia is a protrusion of abdominal viscera through an opening in the diaphragm into the thorax. The hernia may take place through one of the openings normally present for the passage of structures that pass between the two cavities, or through some weak spot in the diaphragm.

Diaphragmatic hernia is either congenital or acquired. In the congenital variety, the hernia may be through the normal opening for the œsophagus, vena cava or aorta, or rarely at some other point. Acquired hernia may occur through the foramen of Bochdalek, which lies just anterior to the quadratus lumborum muscles, or through the foramen of Morgagni, which is an hiatus between the tendinous fibers from the ensiform cartilage and those from the cartilages of the adjoining ribs, or through some point in the tendinous or muscular portion of the diaphragm itself; or, more commonly, through one of the normal openings, most often the œsophageal.

Traumatic hernia may occur anywhere in the diaphragm, as the result of a stab or bullet wound. In crushing injuries, the break usually takes place at one of the weak spots. The sac consists, in true diaphragmatic hernia, of two serous layers closely adherent; one representing parietal peritoneum, the other parietal pleura. In the great majority of cases, however, there is no sac (so-called false diaphragmatic hernia). In traumatic hernia, a sac is never present.

Although any of the abdominal viscera may be occupants of the pleural cavity, the contents most frequently found are stomach, transverse colon, liver, small intestine and omentum. The thoracic organs may be altered in shape by the pressure of the hernia and in cases in which the hernia is of large size there may be pronounced pressure symptoms. This is most apt to follow alterations in the position of the heart and great vessels.

Symptoms and diagnosis. Diaphragmatic hernia gives rise to such indefinite symptoms that its recognition was most difficult before the advent of roentgen ray examination. Briefly, the symptoms may be pulmonary or digestive. Among the former dyspnea, cyanosis, hiccough and pain radiating to the shoulder and down the arm may be mentioned. Change of position may alleviate or even banish the symptoms.

Digestive complaints are colicky epigastric pain and even nausea and vomiting. The pain is usually noticed after eating and the patient may complain of food lodging in the chest. Sometimes gurgling arises, or a rumbling sound may be heard in the chest. The physical signs are also vague and ill defined. Percussion over the lower chest on the side of the hernia may give a tympanitic note and breath sounds be diminished or even absent. The x-ray offers the most certain method of diagnosis and since its use has become general, many cases have been discovered in unexpected and symptomless hernias. Fluoroscopy is a valuable adjunct.

Strangulation. Following closely upon a sudden strain or trauma, strangulation may occur. When this takes place, it most frequently involves the transverse colon or stomach, much more rarely the small intestine. The symptoms are those of intestinal obstruction. Shock is often most pronounced and dyspnea is extreme. Respiration is costal in type, the diaphragm is immobilized and pain is severe, and localized to the epigastric region.

Prognosis. The symptoms of diaphragmatic hernia tend to be steadily progressive. Palliative treatment is of little value. Liquid or semi-solid diet is tolerated better than solids or coarse foods. The operation is not usually undertaken early and the outlook is always dubious. In the newborn the mortality is high, death occurring in the first 24 hours in 90% (Watson).

Treatment. Operation is indicated when the symptoms are severe enough to interfere with the patient's comfortable existence. Only about 100 cases of non-strangulated diaphragmatic hernia have been reported. There are three well recognized methods of approach — the abdominal, the thoracic, and the combined. The abdominal route has the advantages of enabling the operator to confirm diagnosis promptly, and gives better access for intestinal resection, if it be found necessary. It is likewise less shocking to the patient than thoracotomy. It is carried out by means of an upper mid-line or right rectus incision. The condition having been recognized and the diaphragmatic opening exposed, the hernia is reduced by traction. Reduction having been accomplished, the opening is closed by mattress sutures, reinforcing with a second layer of continuous chromic catgut. The actual closure of the opening is a matter of individual judgment. The thoracic method is advisable in traumatic diaphragmatic hernia where there is injury to pleura, lungs, heart or great vessels. The advantages of this route are the greater accessibility of the opening, the easier reduction of the herniated organs and closure of the opening.

LUMBAR HERNIA

Lumbar hernia appears in the lumbar region, or in that portion of the trunk bounded below by the iliac crest, above by the twelfth rib, behind by the vertebral column and erector spinal muscles, and in front by a line drawn vertically from the tip of the twelfth rib to the iliac crest.

Lumbar hernia may be congenital or acquired; the latter may be subdivided into the spontaneous or the traumatic form.

The first authentic case was described by De Garangeat in 1731. Seven years later Petit recorded a strangulated hernia through the space now known as Petit's triangle. It is an exceedingly rare variety of hernia, only 115 cases being found by Watson who collected them from the literature in 1923. It occurs in males three times as often as in females. In Watson's collection it was found to be acquired in type in 85 cases out of

103 in which the cause was stated. Of these 85 cases it was spontaneous in 65 and traumatic in 20. The traumatic factor was scoliosis or abscess of the spine in 16 cases. The congenital type was present in 18 cases. Strangulation had occurred in 11.3 per cent.

Lumbar hernia may present itself through several weak points, of which the two most important are the inferior lumbar triangle or Petit's triangle; and the superior lumbar triangle or triangle of Grynfeltt-Lesshöft. Other defects have been described by Braun, Lieber and others, but they are inconstant.

While not a settled point, recent investigators hold that most lumbar hernias appear primarily in the superior lumbar triangle.

Anatomy. The inferior lumbar triangle, or triangle of Petit, is bounded in front by the external oblique muscle, behind by the anterior border of the latissimus dorsi muscle, and below by the iliac crest. Its floor is the lumbar fascia, beneath which are fibers of the internal oblique muscle and deeper still, the aponeurosis of the transversalis muscle. The dimensions of the triangle vary markedly; in general it may be said to occur more constantly in the adult, though in muscular individuals it may be entirely lacking.

The superior lumbar triangle has its base above, at the lower border of the twelfth rib. Anteriorly, it is bounded by the posterior border of the internal oblique; posteriorly, by the outer border of the erector spine. It is covered by the latissimus dorsi muscle, and its floor is formed by the aponeurosis of the transversalis. This triangular area may in some instances take a more quadrilateral form (rhombus of Lesshöft). Its position is anterior to and above the triangle of Petit and is more constant and larger.

The larger lumbar hernias may be subcutaneous, while small ones often have an overlying thinned-out layer of either external or internal oblique muscle. In some instances no true sac exists, the condition being a subperitoneal lipoma. Rarely, the kidney may be the only content of the hernia and, in these cases, there is no true sac, since this organ is retroperitoneal. Omentum and intestine may occupy the sac, though, because of the anatomical arrangement, they occur less frequently in lumbar hernia than in other abdominal hernias.

The etiology of lumbar hernias of traumatic type may be either operative, traumatic, or following infections. The nature of the trauma is most often extreme violence, such as a crushing blow. Post-operative hernia in this situation depends upon the same factors as does post-operative ventral hernia, i.e., faulty wound healing, or suppuration, chiefly in kidney wounds. Pott's disease with abscess is the most frequent cause of acquired lumbar hernia. Congenital lumbar hernia is very rare.

The symptoms are not pronounced. Slight feeling of fatigue on exertion, or a dragging sensation in the loin may be all that the patient complains of. Owing to its very slow development, it may reach a considerable size before being noticed by the patient. The diagnosis is not difficult in reducible hernias but, if irreducible or strangulated, it may be most difficult. The diagnosis of fatty hernias in this region may simulate an enterocele if reducible, or a strangulated or incarcerated hernia if adherent and irreducible. Abscess, subcutaneous lipoma, and hematoma must be considered in any suspected case of lumbar hernia. We have seen a hypernephroma which simulated this condition. Poliomyelitis may cause a paralysis of some of the abdominal muscles and when this is most pronounced in the lumbar region, it may closely simulate a lumbar hernia.

Treatment. In children, operation is the method of choice, as truss treatment does not prevent growth in size of hernia. In adults, if past middle life, a truss is often fairly comfortable; for the young adult, operation is probably preferable to truss treatment.

Operative treatment. Bull, in 1895, closed the opening by overlapping the muscle and fascia with kangaroo tendon. Dowd's operation consisted in turning up a flap of fascia lata and aponeurosis of the gluteus medius and maximus muscles, and suturing it to the lumbar fascia, external oblique, and latissimus dorsi muscles. A further closure was effected by utilizing a flap of fascia from the latissimus dorsi.

OBTURATOR HERNIA

An obturator hernia may be defined as a hernia passing through the obturator foramen.

This is a rare hernia, less than 400 cases having been collected from the medical literature by Watson up to 1923. It is far more frequent in the female (6 to 1) and in advancing years, the majority being found in the sixth, seventh, and eighth decades. Pregnancy is an important factor. Because of the fact that a swelling is not usually present, the diagnosis was not often made, except in cases that were strangulated, or at autopsy. The diagnosis in the cases that were strangulated was generally made during the course of an operation for intestinal obstruction.

The sac is usually small and often not palpable. Its size is limited by the resistance of the obturator externus and pectineus muscles. It consists of peritoneum, in some cases preceded by a lipoma. The sac content is usually small intestine, omentum is seldom present, and the ovary, fallopian tube and appendix very rare findings.

The important relations of the obturator artery and nerve to the neck of the sac should be understood. The position of the artery is not constant. It lies most often behind and to the outer side of the neck of the sac. Owing to the anastomosis between the obturator and deep epigastric arteries, there is often a vascular circle around the neck of the sac. When the deep epigastric artery furnishes a branch, replacing the obturator artery, the vessel is in a dangerous position.

The obturator nerve usually lies above the artery, on the outer side of the neck of the sac. According to Jaboulay and Patel, when the obturator nerve leaves the canal it expands into an arborescent, trellis-like network which delays the progress of the sac. This often causes pain along the course of the obturator nerve, and occasionally paralysis of the muscles of the abductor group.

The diagnosis, as mentioned above, is difficult. In the series studied by Watson, it was made in only 22 per cent. of the cases that came to operation or died of strangulation. It is most often discovered during laparotomy for intestinal obstruction, but when a swelling is palpable and the presence of a hernia is noted, it is frequently mistaken for femoral hernia. Bimanual examination (vaginal and rectal) is of assistance and should be carefully conducted to rule out the presence of an opening through the foramen. Pain along the distribution of the obturator nerve (Howship-Romberg sign) is the most important symptom, occurring in over 50 per cent. of all cases. The pain is described as a dull ache extending down the inner side of the thigh to the knee. Strangulation is accompanied by a much more severe degree of pain than when the hernia is reducible. When the nerve becomes displaced or pushed out of the way of the advancing sac, or when it lies to the inner side of the sac, where it is free from pressure, there is no pain.

The prognosis of obturator hernia is grave. Non-strangulated cases tend to run a course characterized by repeated attacks of partial obstruction, which become progressively worse and end in complete strangulation.

With earlier recognition and more prompt operative measures, the mortality has fallen from 78 per cent., prior to 1891, to 37 per cent. in the period from 1910 to 1923. Recurrence rate may be placed at about 10 per cent.

The treatment is surgical, taxis being mentioned only to be condemned as gangrene sets in early. There are two approaches for operating upon obturator hernia — the abdominal, and the obturator. The former is the method of choice, since it permits of necessary resections, permits of easier reduction of non-strangulated intestine, and exposes the patient to less danger from accidental hemorrhage from the obturator artery. It is a more rapid method, a matter of no small importance in strangulated cases. In brief, this method consists in laparotomy, division or stretching of the constricting ring, reduction of the contents by gentle traction, and incision of the sac with ligation at its base. The excess of sac may be excised, or can be used as a boss or tampon, being sutured over the obturator foramen.

The obturator route consists in a longitudinal incision, 1½ inches internal to the femoral artery (or midway between artery and pubic spine) its midpoint being over the center of the swelling. The incision is carried through subcutaneous tissue and fascia lata, the pectineus muscle is located and the space between it and the adductor longus identified; the sac which will be found in this situation is now opened and the contents inspected. If gangrene is present, a laparotomy should be performed and the gut dealt with from above. If contents appear viable, the constriction may be stretched by pulling downwards and inwards with the finger, or if this fails, by dividing the internal obturator membrane, due care being taken to avoid injury to the obturator artery which should be felt or seen before division is attempted. After reduction, the sac may be freed, ligated and excised. The pectineus may be used to afford a muscle flap ½ by 3 inches to effect closure of the canal as recommended by Sträter.

PERINEAL OR PUDENAL HERNIA

This is one of the rarest of all varieties of hernia. It is also termed levator hernia. It may be defined as a protrusion of abdominal viscera through the muscles and fascia of the pelvic outlet. Méry's case in 1713, the first to be reported, is doubtful, since from his description it may have been a cystocele. Curade reported a second case soon after, and Astley Cooper described two cases in 1807. Ebner's monograph in 1887 contributed to a better understanding of the etiology and anatomy, and Chase in 1922 published a comprehensive review of the subject. Watson states that Macready was only able to collect 40 cases from the literature in 1893, six of which were in men. In upwards of 13,000 hernia operations at the Hospital for Ruptured and Crippled but one case has been observed.

Anatomy and etiology. Perineal hernia may be divided into two types, the anterior, or direct, and the posterior or indirect. The latter is more common, and all the male cases have been of this type; the sac is also more clearly defined, and larger. According to Chase only those cases due to direct trauma are of the anterior variety.

The triangular area bounded posteriorly by the transversus perinei, laterally by the ischio cavernosus, and medially by the constrictor vaginal is the site through which the anterior perineal hernia emerges. Posterior perineal hernia occurs in men and women in the ratio of 1 to 5. In men it descends between bladder and rectum, perforating the recto-vesical fascia, and the ischiorectal fascia, and presents in the ischiorectal space or in the perineum. In women it makes its way through a defect in the levator ani, or between it and the coccygeus. If it occupies the ischiorectal space and extends below the lower border of the gluteus maximus muscle it may simulate a sciatic hernia.

Congenital predisposition is an important factor, manifest in women by unusually pronounced descent of the rectovaginal fold (Douglas Pouch) and in men by undue relaxation of the rectovesical folds. Injuries to the pelvic floor as a result of childbirth and infections are other factors. The exciting causes are those common to other hernias, namely, heavy lifting, falls, etc.

Symptoms and diagnosis. There are several essential features of perineal hernia which make the diagnosis certain according to Chase. First, it always appears in the posterior portion of the labium majus; second, the lateral half of the swelling is covered by integument, the mesial half by mucous membrane; third, the associated signs of hernia, reducibility, impulse on coughing, etc., are present. These points will serve to differentiate it from other forms of hernia (inguinal, femoral) and from abscess of Bartholini's gland. Rectocele or cystocele should never be confused with it. Perineal hernia gives rise to considerable discomfort but, unless strangulation ensues, it does not endanger life. Mechanical measures for support are ineffectual and operation has been unsuccessful in most of the reported cases. Chase's case, which was followed for eleven months, was entirely well at the end of that period, and he regards the condition as susceptible of cure if one has thorough knowledge of the anatomy and a proper understanding of the principles of operative treatment.

Operation. The abdominal route is the method of choice. The contents are reduced and the sac is inverted and excised. The inner edges are closed and the sac edges approximated. This method is essential, if symptoms of strangulation are present. The perineal route affords better exposure but greater difficulty in closing the internal opening.

In certain cases the combined route has been used to advantage. The perineal incision being used to confirm the diagnosis, free the adhesions in the sac, and to accomplish reduction of the hernia; the abdominal incision being used to close the orifice.

SCIATIC HERNIA

This is the rarest of all hernias. Up to 1923 only 30 cases had been reported in the literature. It was first described by Verdier, in 1753. Comper six years later discovered a case in a woman which contained an ovary.

Sciatic hernia is one which escapes through the greater or lesser sciatic foramen. Most often it occurs through the greater foramen above the pyriformis muscle. It is covered by the gluteus maximus muscle; in its course it extends to the buttock and down the posterior aspect of the thigh. Its extension upward is blocked by the attachment of the gluteus maximus to the ilium, and anteriorly its progress is arrested by the gluteus medius and minimus, whose tendons insert onto the great trochanter. Hence the hernia progresses downward along the course of the sciatic nerve.

Three varieties of sciatic hernia are described. The suprapyramidal which emerges above, and the subpyramidal below the pyriformis; both varieties making their exit through the greater sacrosciatic foramen; the subspinous variety comes through the lesser sacrosciatic foramen, below the spine of the ischium. There is only one recorded example of the latter in the literature.

Etiology. Congenital defect is the cause of six of the 30 cases collected by Watson, since all were born with the hernia. Age — the majority of the subjects were over 40 years of age. Sex plays no role, as the incidence is about equal. Accidents or operations in the gluteal or sacral regions may be etiological factors.

Symptoms and diagnosis. The chief symptom is pain radiating down the course of the sciatic nerve. Muscular weakness may be present in extreme cases. A slight swelling in the gluteal region may be the only objective sign. If the hernia is large, an impulse may be obtained and the mass may be partially or wholly reducible. In most cases the diagnosis is not made until strangulation has occurred. X-ray examination may confirm a suspected diagnosis. Small intestine is the most frequent finding in strangulated cases. Myomas, lipomas, gluteal abscesses and other swellings in this region have to be considered in the diagnosis. However, the absence of the characteristic signs of hernia make it possible to rule out a sciatic hernia in such cases.

Prognosis. Owing to the fact that a majority of the cases reported remained undiagnosed until strangulation had occurred the prognosis must be regarded as grave; ten cases were operated upon with two deaths, and seven were found at autopsy, in four of which death was due to strangulation.

Treatment. As in the other rarer types of hernia, mechanical treatment is not successful and the abdominal route is the choice of the operative methods. It is more rapid, less beset with dangers of hemorrhage, the sac can be ligated higher and the opening closed more satisfactorily; furthermore, strangulation, if present, can be dealt with promptly and more safely.

HERNIA IN THE INTERSIGMOID FOSSA

This very rare form of internal hernia takes place into the space known as the intersigmoid fossa which lies between the sigmoid mesocolon and the parietal peritoneum of the posterior abdominal wall. When the sigmoid is drawn upward and to the left the orifice may be seen at the point where the sigmoid mesocolon is inserted. Treves found this fossa present in 52% of cases; Moynihan and Jonnesco in 70%; and Waldeyer in 84%. The fossa is almost always present at birth and becomes less constant with advancing years. After fifty it is usually absent. The fossa lies behind the mesosigmoid and in front of the parietal peritoneum. The opening is oval or round and bounded anteriorally by a fold of peritoneum containing the sigmoid vessels.

The peritoneum forming the posterior wall of the fossa covers the common iliac artery and ureter at the point where the latter crosses the artery. In size it varies from a mere dimple to a cavity two to three inches or more in depth.

The fossa has been described as usually being of the size and shape of a finger cot for an average middle finger. Up to 1908 there were only three authentic cases reported, namely, Eve's, MacAdam Eccles' and W. B. Coley's. The latter case was in an infant three days old, dying seventy-four hours after birth of intestinal obstruction. Autopsy two hours after death revealed a large retro-peritoneal hernia in the intersigmoid fossa. It contained most of the small intestine and extended up almost to the costal margin, occupying the left side of the abdomen. According to Watson, diagnosis has never been made prior to operation.

The treatment consists in reduction of the strangulated intestine, careful attention being paid to the sigmoid vessels which lie in the anterior margin of the neck of the sac.

HERNIA THROUGH THE FORAMEN OF WINSLOW

This type of hernia depends upon several predisposing factors, among which may be mentioned a large foramen of Winslow and unusually long mesentery and, according to Jeanbrau and Riche, to some violent efforts which cause a portion of the small or large intestine to be forced through the foramen of Winslow into the lesser peritoneal sac.

Moynihan mentions among the causative factors the absence of secondary fusion of the ascending colon to the posterior abdominal wall. The condition is more common in males than in females. The symptoms are those of an acute intestinal obstruction of sudden onset with hyperacute pain. A mass may be felt in the epigastric region which on percussion gives a tympanitic note. The diagnosis, as in other types of internal hernia, is rarely, if ever, suspected prior to operation. With the abdomen open, however, the condition is usually apparent. As a rule, the intestine can be withdrawn through the foramen by gentle traction.

As we have seen in other types of internal hernia, the neck of the sac contains vital structures, i.e., portal vein, common bile duct, and hepatic artery. Therefore, should traction fail to reduce the contents the lesser sac can be opened by incising the gastro-hepatic or gastro-colic omentum, as recommended by Moynihan. The distended coils may then be incised and emptied of their contents and the incisions closed. The gut thus reduced in caliber is safely withdrawn by traction without enlarging the foramen.

STRANGULATED HERNIA

A strangulated hernia is one in which the blood supply of the contents of the sac and possibly the sac itself is partially or completely obstructed.

Etiology. Predisposing causes:

Sex. The percentage of strangulated hernias is higher in females although more frequently encountered in males, due to the fact that a larger majority of hernias occur in them.

Age. Infants are more susceptible to strangulation than older children, the majority occurring during the first two years. In adults strangulation is more common in middle life and old age.

Site of Hernia. Strangulation is most frequent in femoral hernia due to the inelasticity of the femoral ring occurring about five times as often as in inguinal and umbilical.

Size of Hernial Ring. This is the most important predisposing cause. If the hernial ring is small or the neck of the sac has become thickened and contracted from wearing a truss, obviously a loop of gut is much more liable to be caught and its blood supply interfered with than if a large hernial orifice existed.

Reducibility. An early reducible hernia rarely strangulates. If reducible with difficulty or irreducible the danger of strangulation is much greater.

Exciting causes. Straining, coughing, lifting or any other factor causing a sudden increase in intra-abdominal tension is a sufficient exciting cause.

Pathology. The strangulation usually occurs at the neck of the sac (inguinal, femoral or umbilical rings) although in inguinal hernia it may occur lower down in the canal (external ring) and in any variety an omental band or constriction within the sac may be the cause of the strangulation.

The sac is tense edematous and congested. At first it contains clear serum but as the venous stasis increases and there is a migration of blood cells through the walls of the mesentery and intestine it becomes light red and later brownish in color. The fluid is at first sterile and odorless but as the bacteria pass through the intestinal wall it becomes turbid and has a foul fecal smell.

The contents of the sac are usually omentum and intestine although either may alone be present. The mechanical effects of strangulation as stated by Hutchinson are as follows: (1) arrest of passage of intestinal contents (with rapid putrefactive changes due to bacilli and distention with gas of the loop involved); (2) arrest of circulation, first in the veins then the arteries, with the consequences thereof; (3) severe irritation and later paralysis of the sympathetic nerves involved in sac and contents; (4) injury to the coats of the intestine leading to perforation and gangrene; and (5) damage to the vessels and nerves in any contained mesentery or great omentum.

At the onset the irritation of the nerves causes peristalsis which wedges the intestine more tightly into the hernial orifice with gaseous distension of the loop or loops below the constriction. The more the distention below the tighter becomes the constriction above, hence complete vascular obstruction and the rapid advance of gangrene. In cases of strangulation with gradual onset of symptoms the gut involved is usually jejunum which has a stronger muscular wall and does not so readily distend with gas.

The distention of the gut makes the sac tense and the impulse on coughing disappears. As the circulation becomes obstructed, first venous and later arterial, the wall of the gut becomes edematous with a change in color ranging from purple red to black and hemorrhages occur into the submucous and subperitoneal layers of the intestine. So far even though the loop be coal black there is a good chance of recovery if the constriction is relieved providing the gut is resilient and neither perforated nor deeply ulcerated from within.

If complete vascular obstruction continues combined with distension produced by bacilli and their toxins or by the trauma of pressure against a sharp edged ring, after a variable time ends in gangrene or perforation. The sites of greatest danger are at the point of constriction and the convexity of the loop. Gray sodden patches on the convexity of the loop with a complete loss of resiliency (compared to wet blotting paper) are conclusive evidence of gangrene and such a loop must never be reduced.

Peristalsis above the constriction causes this part of the bowel to be distended with an accumulation of feces mucous; and gas, and putrefaction advances rapidly with the multiplication of countless bacteria. The toxins are absorbed and often give rise to a fatal toxemia.

Below the constriction the intestine is empty and of normal size and color.

Symptoms. These are well defined and the diagnosis is usually easy. The important subjective symptoms are pain, nausea and vomiting, constipation,. prostration and shock.

Pain usually comes on suddenly following some exertion and is noticed at the site of beginning constriction. It is sharp and colicky in character and is due either to peristalic waves from above the obstruction attempting to overcome the constriction or to dragging on the mesentery or omentum. As the strangulation increases the pain becomes more severe and does not stop as long as peristaltic contractions are present.

Nausea and vomiting. Nausea alone may be present if the obstruction is only partial. Vomiting is a most important symptom and is almost invariably present after the obstruction is complete and if unrelieved occurs repeatedly until the vomitus becomes fecal in character. Toward the end the patient may be suffocated by this vomit.

Constipation is not immediate and should never be looked for as a symptom. When the entire lumen is obstructed it is complete, but if incomplete, gas and feces may be passed by rectum and diarrhea may be present at the start.

Prostration and shock are serious symptoms and the diagnosis must be made if possible before their advent. They may occur early in infants and in the aged and make for a serious prognosis.

Objective. On palpation a tense painful irreducible mass is felt at one of the hernial openings which does not give an impulse on coughing. It is important to remember the possibility of a nipping of a portion of the lumen of the bowel (Richter's hernia) with no local symptoms.

Diagnosis. Needless to say this must be made early. The presence of a tender irreducible mass at the site of a previously reducible hernia is sufficient justification for operative interference. Nausea and vomiting usually clinch the diagnosis, but operation should not be delayed until they develop. Never wait for the classical symptoms of intestinal obstruction. Finally always remember to examine carefully for strangulated hernia in all supicious cases of intestinal obstruction.

Differential diagnosis. In partial enterocele (Richter's hernia) and strangulated omental hernia the symptoms are not as marked but the operative indications are the same.

Hydrocele of the cord in young children may be mistaken for a strangulated hernia. They feel entirely different, the hydrocele may be very tense but is not tender and is more movable. If there is any doubt of the diagnosis operate on suspicion especially if vomiting is present.

Undescended testicle should not cause any difficulty but if the testicle is strangulated and the scrotum is not palpated during the routine examination the diagnosis of strangulated hernia will probably be made.

Treatment. Immediate operation is indicated in all strangulated hernias. Taxis may be attempted if the case is seen early before strangulation is definitely recognized, but only by a surgeon skilled in knowing how to apply it. No force should be used and gentle pressure is made with one hand raising and compressing the hernia while the other fixes the neck of the sac. Skilled fingers will readily detect a gurgle if the hernia starts to reduce and will equally quickly detect the degree of constriction at the neck of the sac and determine if further attempts at taxis are either futile or dangerous. In children who cry at the slightest additional pain taxis should only be attempted under anesthesia.

For those less experienced in the surgery of hernia administration of morphine, elevation of the foot of the bed with the application of an ice bag is a much safer procedure than taxis and nearly as effectual.

The danger of trauma to the strangulated loop of gut is very great if taxis is persisted in or if attempted by one of little experience. Elevation of the foot of the bed does no harm except to postpone the time of the operation.

Reduction "en Masse" or "en Bloc" occurs when the hernia is reduced without relieving the constriction. Several varieties are recognized:

(1) A double sac may exist and the strangulated loop is reduced into the empty loculus.

(2) The sac containing the strangulated gut is forced into the subperitoneal tissue or between the layers of the abdominal wall.

(3) The neck of the sac is torn and the intestine is squeezed through the rent into the subperitoneal layer.

(4) A ring of peritoneum encircling a loop of gut is torn off the hernial neck and both are pushed into the peritoneal cavity.

After the supposed reduction the patient becomes rapidly worse, the vomiting and local pain increase and symptoms of shock soon appear. On palpation the original hernia has disappeared but if it has been displaced behind the abdominal wall or between its layers a sense of fullness is felt.

Fortunately this condition is rarely seen in the present day. All physicians have a wholesome respect for a suspicious case of strangulation and the patient is immediately sent to a hospital without any vigorous attempts at reduction having been made.

Operative Treatment. If vomiting has been pronounced, preliminary lavage is a great aid in preventing post-operative complications.

Many surgeons feel that local anesthesia should be selected in all cases of strangulation. If the general condition of the patient is poor it undoubtedly has advantages. Gas and oxygen or ethylene administered by a competent anesthetist add little to the shock and certainly expedite the operation very decidedly, and we are inclined to prefer them in the majority of cases.

Operation for strangulated inguinal hernia. The sac is exposed as in an operation for simple hernia. Do not attempt to deliver the sac from its bed but incise it immediately with a sharp scalpel, care being taken not to injure the underlying gut. Enlarge the opening with scissors and find the point of constriction which is usually at the internal ring. If at the external ring, it has already been relieved by the incision of the external oblique aponeurosis. Divide the constriction from within out on the outer side to avoid injuring the deep epigastric vessels. In direct sacs which rarely strangulate divide the constriction on the inner side for the same reason.

Having relieved the constriction pull the loop of bowel down gently and examine the site of constriction as it is at this point that the injurious effects of the strangulation are most marked. In the majority of cases as soon as the constriction has been relieved the circulation of the affected loop will immediately improve and if it does not, cover the part with hot towels and wait a few minutes. If any signs of returning circulation are noted and if the luster of the peritoneal coat has not disappeared and the gut has not lost its resiliency it can usually be returned with safety.

Reduction must be attempted with great care to avoid further injury to an already damaged gut. A retractor placed within the neck of the sac with elevation of the internal ring may help but if still difficult incise the internal oblique and transversalis muscles outward from the ring and divide the peritoneum from the neck of the sac in the same direction so that the bowel can easily be returned to the abdominal cavity. If omentum is present separate all adhesions and reduce or resect depending on its condition. The operation is completed as in a simple hernia.

Operation for strangulated femoral hernia. If the diagnosis is clear the inguinal approach is the one of election. In a border line case the femoral may be chosen. It is not uncommon to find a beginning strangulation of the sac and properitoneal fat with no contents save a little bloody fluid. It is easy to free the neck and pull it down so that the transfixing suture can be passed through normal tissue. If strangulated omentum alone is found it can usually be freed and ligated in normal tissue.

A partial strangulation or nipping of a portion of the lumen (Richter's hernia) is more common in femoral hernia and one should always be on the alert to recognize this condition. If the nipped portion slips back during manipulation its viability may be questioned and if any doubt exists the abdomen should be opened through a low right rectus incision and the site of strangulation inspected.

The site of strangulation is at the femoral ring and is caused by Gimbernat's ligament. An attempt is made to dilate the ring by passing the tip of the finger between the intestine and Gimbernat's ligament. If this is not possible the ligament must be nicked, care being taken not to injure an abnormal obturator artery. It may be wiser and safer to partially divide Poupart's ligament but if this is done it is very difficult to effect a radical cure. After dilating the ring by one means or another pull the loop of gut gently down and inspect the site of constriction. If viable reduce and repair the ring in the usual way.

If the inguinal incision is selected the peritoneum is opened above the neck of the sac and after dilating or incising the femoral ring the contents are reduced and their condition noted.

Operation for strangulated umbilical hernia. After the neck of the sac is exposed and incised as in an operation for non-strangulated hernia, the constriction is divided from within out, the fingers guarding the intestine. The gut involved may be large or small intestine or both. If viable the remainder of the operation is completed as described under umbilical hernia.

Strangulated hernia in which the omentum or gut is not viable. Resection of a portion of gangrenous omentum is a simple procedure. After relieving the constriction separate the adhesions and draw the omentum down ligating through normal tissue, and excise.

Gangrenous intestine presents a more complicated problem. If a single perforation or threatened perforation is present and the adjacent tissue is fairly normal, a double row of purse string sutures may close it satisfactorily without narrowing the lumen too much. This simple method is seldom applicable and usually a resection is necessary.

If the gut is gangrenous it must be excised. After drawing the loop down so that the gut above the constriction is well exposed either an end to end or side to side anastamosis is performed according to the usual technique. In strangulated femoral hernia this must be accomplished either through an inguinal or right rectus incision. In deciding between an end to end and lateral anastamosis the caliber of the two portions to be united must be considered. If the proximal end is not too much dilated the former is the more rapid method, but if there is too great a disparity in their caliber side to side anastamosis is preferable. The Murphy button overcomes this difficulty many times and as speed is always an important factor this mechanical device can frequently be used to advantage.

If the patient's general condition is such that the surgeon feels a resection is not indicated, the gangrenous loop of bowel may be left outside the wound and a tube inserted. After adhesions have formed the loop is removed with a cautery and subsequently an attempt may be made to reëstablish its continuity either by suture or a Murphy button.

When the obstruction has existed for some time and the gut proximal to the constriction is markedly dilated an ileostomy is indicated to combat the threatened toxemia. Enormous amounts of fecal material are frequently drained from the dilated bowel by this method, providing a paralytic ileus does not develop, and it undoubtedly is a great aid in combating the toxemia which so many times proves fatal after a successful anastamosis has been performed.

CLASSIFICATION OF COMPLICATIONS OF HERNIA OPERATIONS

The complications of hernia operations may be divided into two groups: those arising during the operation and those developing after the operation.

The principal operative complications are:

1. Injury to the vas deferens or its accompanying spermatic vessels.
2. Injury to bladder.
3. Injury to intestine or omentum.
    a. Sliding sigmoid or cecum.
    b. Adherent small intestine or omentum.
4. Injury to blood vessels.
    a. Deep epigastric artery and vein.
    b. Iliac artery and vein.
5. Misplacement of testis (beneath layer of fascia leading to thigh).
6. Failure to recognize the presence of one of the components of a "saddlebag" or direct and indirect hernia; an accompanying femoral hernia, or a hernia through the linea semilunaris.

The post-operative complications are divisible into two groups: Immediate or Early, and Late; they may also be classified as General or Local.

Early or immediate.

A. General
  1. Acidosis
    a. In children
    b. In diabetics
  2. Pulmonary Complications
    a. Bronchitis
    b. Pneumonia
    c. Pulmonary embolus
    d. Massive collapse of the lung
    e. Tuberculosis — aggravation of a latent pulmonary tuberculosis
  3. Cardiorenal disease with cardiac failure or uremia.

B. Local
  1. Gastric dilation
  2. Tympanites
  3. Wound infection
    a. Infected hematoma
    b. Superficial infection
    c. Deep infection
    e. Infection associated with fascial sutures
  4. Scrotal hematoma
  5. Epididymitis
  6. Peritonitis
  7. Sloughing of testicle
  8. Femoral Thrombophlebitis

Later complications.

1. Sterile abscesses with sinus formation from use of non-absorbable sutures or sutures with prolonged periods of absorption.

2. Orchitis (hard testicle)
3. Hydrocele
4. Pain
  a. Neuritic
  b. Due to beginning recurrence
  c. Unexplained

SECTION II

OPERATIONS UPON THE RECTUM AND ANUS

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EXCISION OF THE RECTUM BY THE COMBINED METHODS

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CHAPTER I

METHODS OF EXAMINATION OF THE RECTUM AND ANUS

Inspection. For the examination of male patients, the knee-elbow position, with the thighs vertical, is the most generally useful; female patients may be in the left lateral semi-prone position, the buttocks slightly over the edge of the couch, the hips and knees well flexed, the upper thigh crossed over the lower, the under arm brought out behind the patient's back, and the face turned towards the couch.

The buttocks should be drawn gently apart and the anus and surrounding region inspected. If there be discharge present it should be wiped away and its source noted. The radiating folds of skin should be examined for any orifice, crack, or excoriation. It will be noted if the skin be supple and normal in appearance, or if it has an opaque look, as in cases of chronic pruritus ani. The orifice of a fistula, any external piles, tags of skin, ulceration, mucous patch, papilloma, or eruption of any kind will be at once seen. The condition of the sphincter will be noticed, whether it is tightly contracted, as when anal fissure is present, or obviously relaxed, as in some cases of carcinoma of the rectum, in nerve lesions such as tabes dorsalis, or in elderly people, also in old cases of prolapse of one or more coats of the bowel, or of internal piles. It should be noted that the sphincter is normally more powerful in males than in females. If internal piles be suspected they may often be made to protrude by everting the anal margin with the fingers, while making the patient strain down. Pressure on the perianal region by the finger will reveal any induration due to an abscess, or the track of a fistula, or perhaps a boggy sensation due to a cavity containing tuberculous debris.

Digital examination. The external examination being completed, the index-finger, lubricated with vaseline, should be gently inserted into the bowel, the patient being at the same time directed to strain down, if necessary, to relax the sphincter. If a fissure be present, considerable pain is often caused and the finger is tightly gripped by the sphincter, although usually the pain can be modified by pressing well forwards, as a fissure is generally situated posteriorly. The finger carefully swept round inside the bowel will detect the presence of foreign bodies or fæcal material, whether the bowel is 'ballooned,' as in some cases of carcinoma of the rectum, also if the mucous membrane has its normal velvety feeling. There may be slightly depressed areas where this is lost, indicating the presence of ulceration; the edge of an ulcer, perhaps thickened, may be felt, and the mucous membrane may not glide as freely as it should over the muscular coat of the bowel. A small depression, usually within an inch of the anus and between the two sphincters, may be the internal orifice of a fistula; if situated higher up, it may be at the apex of a small projection and its track may be felt as an elongated induration outside the mucous membrane.

A bi-digital examination is often useful, the index-finger being within the bowel, the thumb of the same hand applied to the parts around the anus; gentle pressure by the thumb and finger on the parts between them will at once lead to the detection of any induration or the reverse, also to any abnormality of the coccyx. Sometimes the squatting position with the patient straining down may be necessary to bring a tumour within reach; or the lithotomy position with the patient under a general anæsthetic, to enable the surgeon to make a bi-manual examination to decide if a growth be movable or not. It is most important to examine every part of the mucous membrane within reach; care must be taken to pass the finger well back into the hollow of the sacrum, or it may pass up in front of a growth situated in the posterior wall of the bowel and lead to its being overlooked. The finger passed up the bowel may find its lumen gradually becoming narrower, due to the presence of a fibrous stricture. Tumours outside the bowel will be felt, perhaps, pressing on to and partly occluding its lumen; the mucous membrane will be smooth, velvety, and movable over the tumour. A common error is to mistake the uterus for a tumour. In some cases it will be advisable to give a simple enema and when it has acted to at once inspect the anus, when a prolapse of mucous membrane, internal piles or a polypus, not otherwise visible, may be brought into view.

Specula. For inspection of the anal canal, Mummery's anal speculum is a very convenient form (see Fig. 37). For the inspection of the whole circumference of the anal canal and the parts immediately above, Kelly's shortest proctoscope is the most convenient instrument (see Fig. 38). It is 2¼ inches in length and equal in diameter to a No. 10 rectal bougie. The author's modification, which consists of a rim of metal round the distal extremity, makes the instrument much less likely to damage the mucous membrane when the obturator is removed. As originally made, the end of the instrument was too sharp and liable to cause abrasions. For inspection of the bowel higher up, Kelly's proctoscopes are made of various lengths, but for this purpose they have mostly given place to the pneumatic sigmoidoscope. The bivalve speculum (see Fig. 39) is useful when douching the rectum or making applications to its lower part and sometimes for purposes of examination.

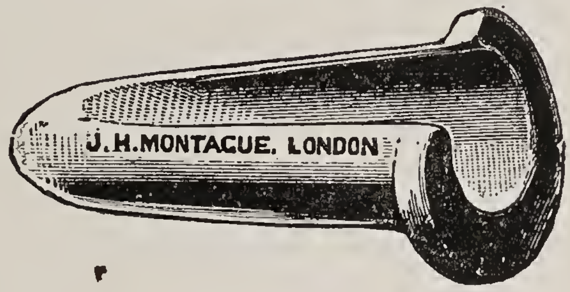

Fig. 37. Mummery's Anal Speculum.

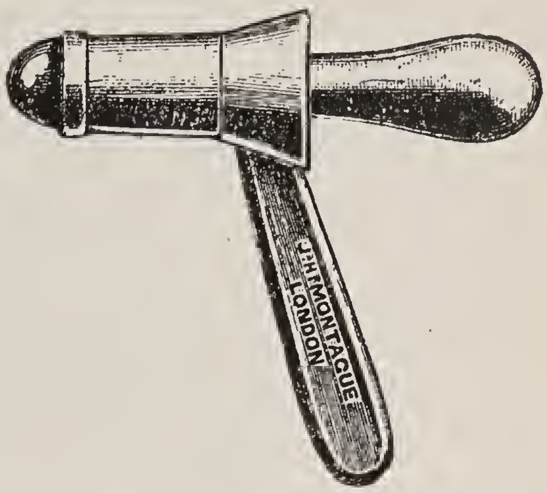

Fig. 38. Kelly's Shortest Proctoscope.

In introducing these instruments, they should be passed straight in for the first 1½ inches and then directed backwards towards the hollow of the sacrum, because the axis of the anal canal is almost at right angles to that of the rectum.

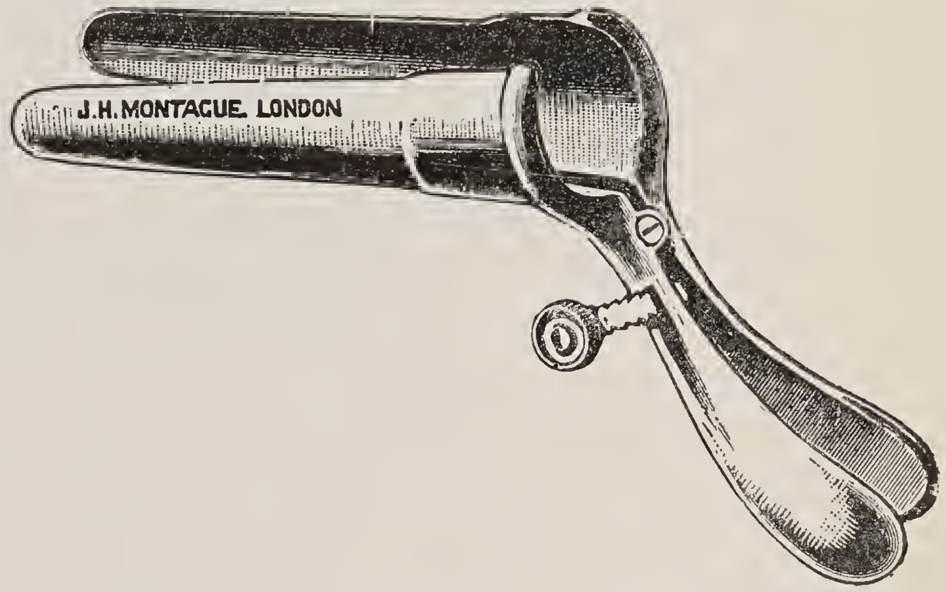

Fig. 39. Dilating Anal Speculum.

The sigmoidoscope. This instrument is of the greatest use for the inspection of the rectum and sigmoid colon; a better view is obtained than with the proctoscope and its introduction is easier and safer. Strauss's sigmoidoscope consists of a metal tube (see Fig. 40) 14 inches or 35 centimetres in length and equal in diameter to a No. 8 rectal bougie, *i.e.* 2 centimetres. The tube is marked externally in inches or centimetres, and is fitted with an obturator to facilitate its introduction, also with a detachable handle. On removal of the obturator, a small electric lamp, carried on a long rod, is inserted and passed close to the distal extremity of the tube. The rod is attached to a metal collar which is fixed into the proximal end of the tube by a bayonet-joint. Through the collar the wires from the lamp are conducted to a couple of terminals. The collar is closed at its proximal end by a glass window in a metal rim, which fits into the collar by a bayonet-joint. A small hand-bellows is connected by a stop-cock to the proximal end of the tube. The handle and stop-cock prevent the instrument from being introduced more than 12 inches or 30 centimetres, but this is sufficient to examine the entire rectum and the greater part of the sigmoid colon. In Tuttle's sigmoidoscope, the rod carrying the lamp has a separate tube, lying outside the visual tube and terminating in a small crystal glass bulb for the lodgment of the lamp. This somewhat increases the circumference of the instrument, but the lamp is protected from fouling by fæces or discharge, and it does not interfere in any way with the visual area.

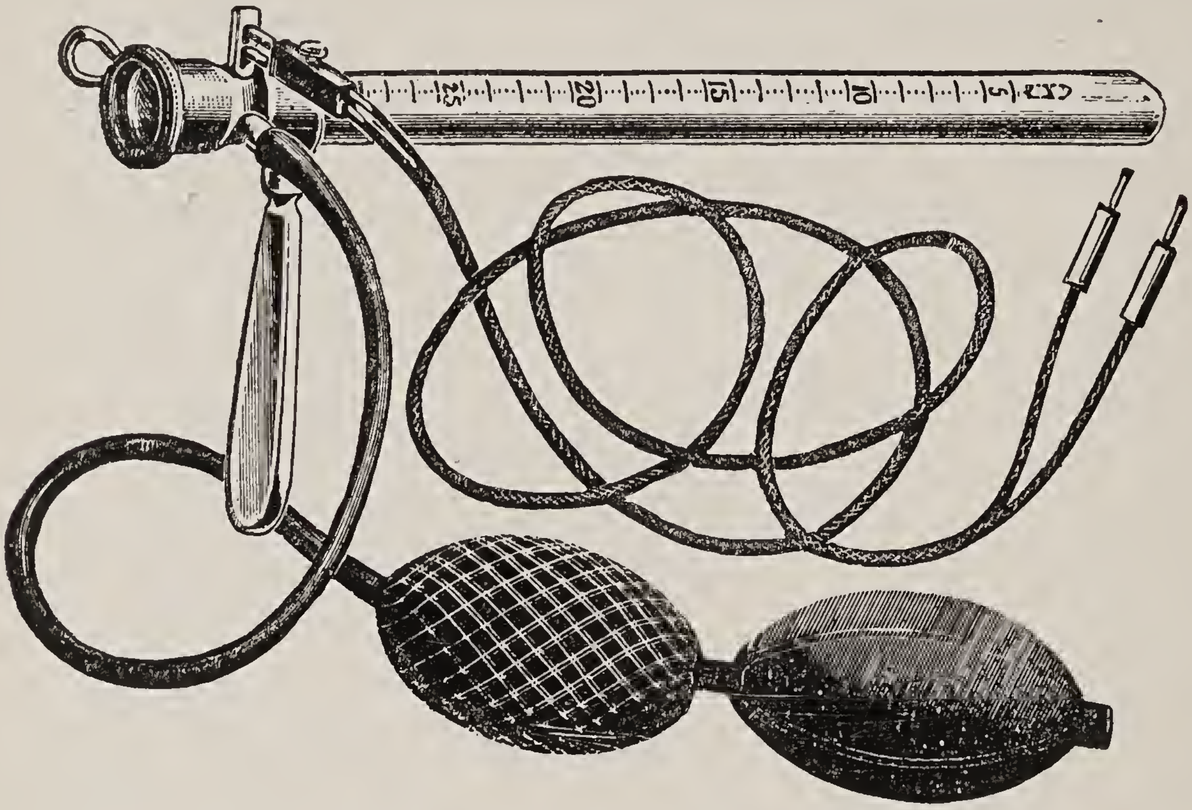

Fig. 40. Strauss's Sigmoidoscope.

Mode of use. For a successful examination with the sigmoidoscope, the bowel must be well emptied, if necessary by an aperient given at least twenty-four hours previously and one or more enemata on the morning of examination.

The patient is placed on a high couch or table, and all tight garments over the abdomen are loosened or removed. The genu-pectoral position is the best for both sexes when no anæsthetic is used, but for an examination under anæsthesia the left semi-prone position, with a good hard cushion under the pelvis, is the best. Anæsthesia is not required except in very sensitive subjects. The tube, warmed and lubricated with vaseline, is inserted while the patient relaxes the parts by straining down, and the obturator is removed as soon as the tube has reached the rectal ampulla, *i.e.* the dilated portion of the rectum immediately above the anal canal. The collar, closed by the glass window and carrying the rod and lamp, is now attached to the tube, and the light is switched on. Air is pumped in by means of the bellows, and the instrument, under the guidance of the eye, is passed upwards and backwards towards the sacral concavity. The proximal end of the tube is now raised, to allow its distal end to pass over the pelvic brim. When this has been accomplished, its onward progress is generally easy. If during an examination the view is obstructed by a small amount of fluid or liquid fæces, if Strauss's instrument is being used, the lamp should be removed, and the proximal end of the tube directed downwards; the fluid will at once run out through it. Or the fluid may be removed by pledgets of cotton-wool on an applicator or held in long crocodile forceps; the lamp and window are then readjusted and the examination continued.

Soon after the introduction of the instrument the lowest valve of Houston may cause some little difficulty in its onward passage. This is soon overcome by frequently altering the axis of the tube, and as the pressure of the air distends the bowel and draws the mucous folds out of the way, the lumen becomes apparent and the instrument is passed higher and higher. When it has reached about the level of the second sacral vertebra, the rectum often appears to end in a blind pouch. When this happens it is necessary to withdraw the sigmoidoscope a little and direct its extremity to one or the other side in order to enter the sigmoid loop, which in these cases appears to join the rectum at an angle, and its entrance may be more or less hidden by a fold of mucous membrane. In the majority of cases, when this difficulty arises, the entrance will be found on the right side.

Difficulties may be met with owing to the bowel not having been properly cleared out, to hypersensitiveness on the part of the patient, to the presence of tumours or strictures within the bowel, or tumours or adhesions or inflammatory extravasations outside the bowel, partly occluding it by pressure.

CHAPTER II

OPERATIONS UPON THE ANUS

FOR PRURITUS ANI

Cauterization. *Indications.* Where in long-standing cases medical treatment has failed to give relief.

Operation. The patient having been anæsthetized, the anus is forcibly dilated. If any tags or radiating folds of skin are present they should be snipped off with scissors. The flat side of a Paquelin's cautery point at a white heat is then lightly applied to the whole of the affected anal skin. If every part of the diseased area be carefully stroked twice with the cautery at this temperature, neither too much nor too little burning will be produced, the epithelium only will be partially destroyed and ulceration will not be caused. The applications should start just inside the anus and extend radially.

After-treatment. The patient should be kept recumbent for a few days and an antiseptic ointment, such as eucalyptus, kept constantly applied. The parts should be irrigated twice daily with an antiseptic lotion. The bowels should be opened in two or three days' time by the administration of an aperient.

Results. Some cases are cured; in others the relief is only partial, but in these local applications which previously had failed will now have the desired effect; whilst in a small percentage the operation fails.

Ball's operation. *Indications.* This operation is indicated in intractable cases due to some change in the sensory nerves of the affected area. Its object is the division of all the terminal branches of the affected nerves.

Operation. The part having been shaved and prepared in the usual way, the patient is placed in the lithotomy position and a semicircular flap of skin and subcutaneous tissue is dissected up from without inwards towards the anus, raising the whole of the affected area on one side. This is repeated on the opposite side, taking care to leave a bridge of skin both in front and behind about an inch wide. These bridges, both in front and behind, are undercut to well beyond the area of irritation in order to divide any nerve filaments; the outer concave edges of the incisions are also undercut for about one-third of an inch. The flaps are raised as far as the anus, exposing the fibres of the external sphincter, and the dissection should be continued up to beyond the mucocutaneous junction. All bleeding being completely arrested, the flaps are replaced and sutured in position by interrupted silkworm-gut sutures, and the wound is dressed with gauze and collodion. A rubber tube should be inserted into the rectum in order to convey flatus away from the operation area.

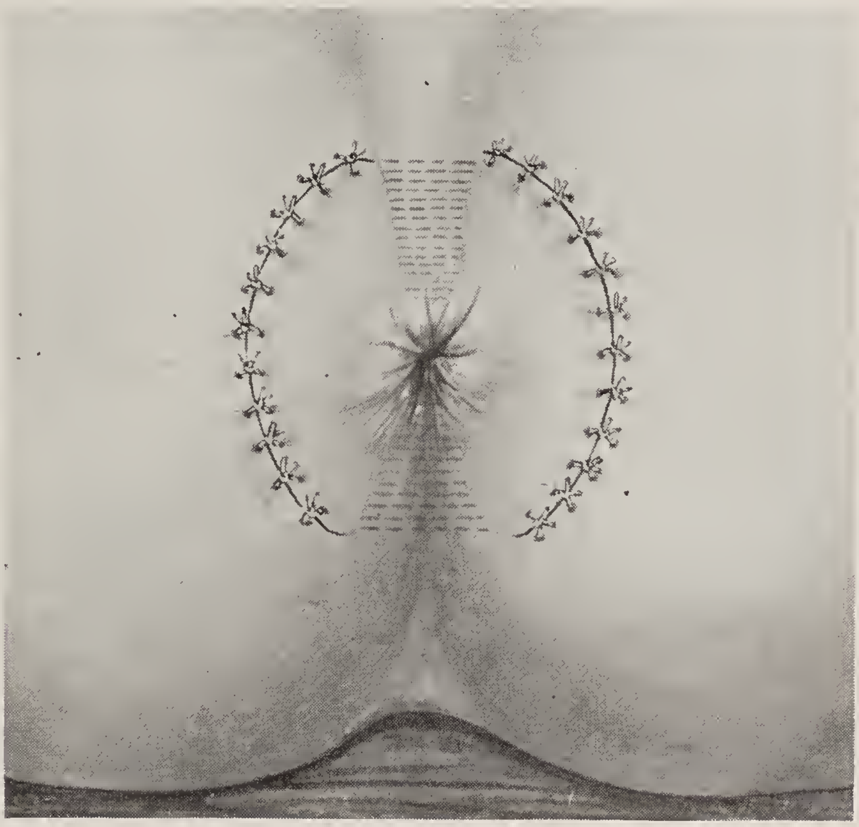

Fig. 41. Ball's Operation for Pruritus Ani. The flaps, which have been turned inwards as far as the mucous membrane of the anal canal, have been replaced and sutured. The fine transverse lines indicate undercutting of the bridge of skin between the flaps. The undercutting beyond the concave edges of the incisions is not indicated.

After-treatment. The patient should be kept recumbent for ten days; the bowels should be opened on the fourth day after operation. If the patient remains comfortable the wound should be inspected after the bowels have acted, and will usually be found to have healed by first intention. The part should be cleansed and irrigated with an antiseptic solution two or three times daily and a dry boric lint or cyanide gauze dressing kept applied. The stitches, if not causing irritation, should be removed at the end of a week.

Complications. Provided the wound be kept aseptic these are absent. If the wound becomes infected the stitches will have to be removed, as a suppurating wound will be present and there will be risk of the formation of an inguinal bubo. Healing will be delayed, but will take place under the use of antiseptic fomentations, and, if no extensive sloughing occurs, with no permanent detriment to the patient.

Results. The pruritus is cured and cutaneous sensation gradually returns in the operation area.

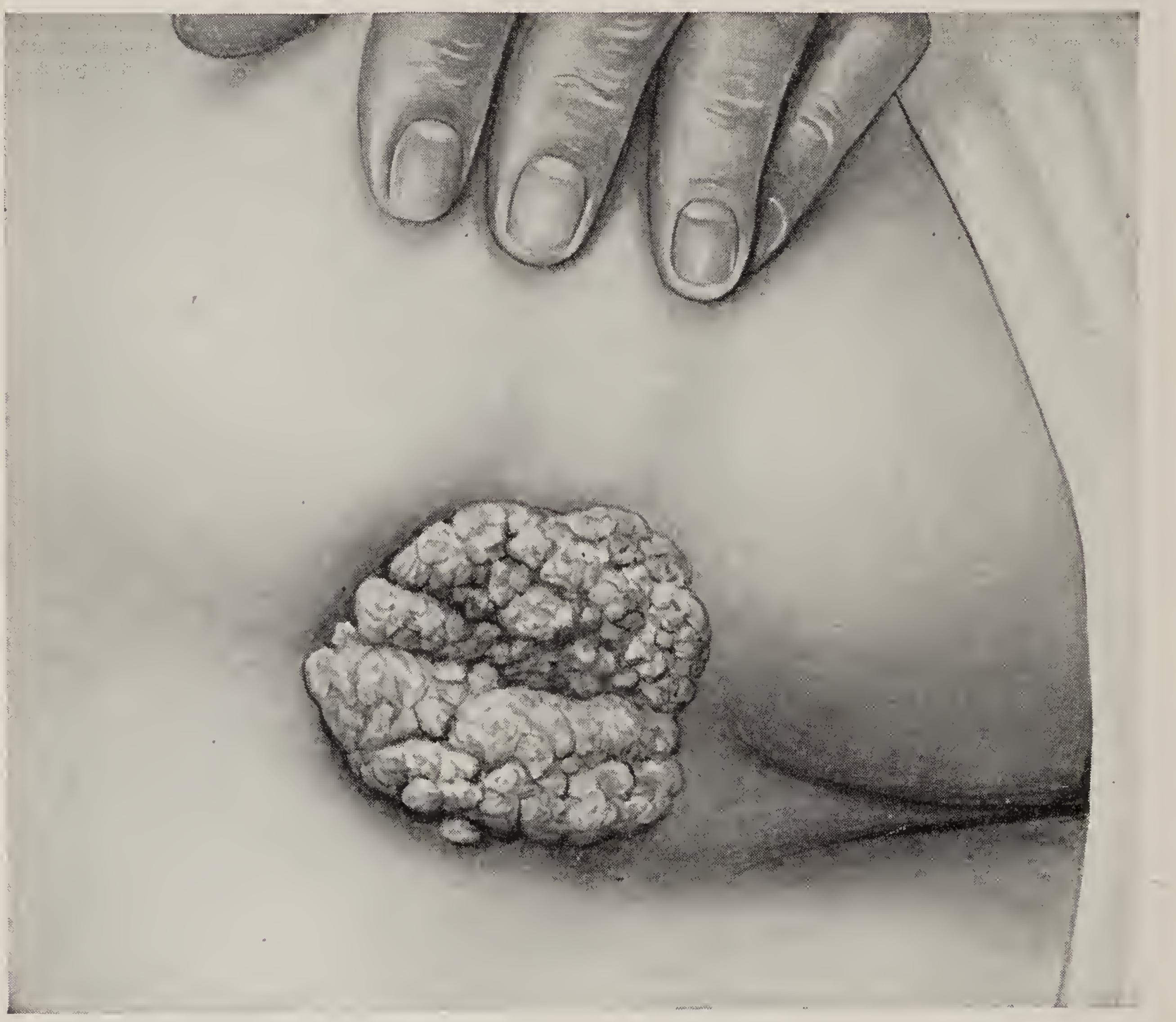

Fig. 42. Extensive Papillomata of the Anus.

FOR ANAL PAPILLOMA

When small they are best treated by the careful application of fuming nitric acid, taking care that the action of the acid is limited to the papilloma, without injury to the healthy skin. When the growths are too extensive for this treatment, as shown in Fig. 42, they should be completely cut away with scissors and their bases cauterized with pure carbolic acid, after stopping the hæmorrhage with pressure for a short time. A cyanide gauze dressing should then be applied and held in place by a firmly applied bandage.

FOR ANAL FISSURE OR ULCER

In a comparatively recent case, the patient is anæsthetized—gas and air or gas and oxygen are sufficient in most cases—and the sphincters are fully stretched by the fingers; any sentinel pile or tag above or below the fissure is snipped off with curved scissors.

If the fissure is of long standing an incision is made with a straight blunt-pointed bistoury through about one-third of the thickness of the external sphincter, after both sphincters have been dilated; the incision should start a little above and end a little below the ulcer, and the outer end of the incision should extend a little more deeply than the inner. After the operation, a little cotton-wool wrung out in sublimate lotion (1–1,000) is placed in the wound, and the subsequent treatment should be conducted on lines similar to that after operation for fistula (see p. 103).

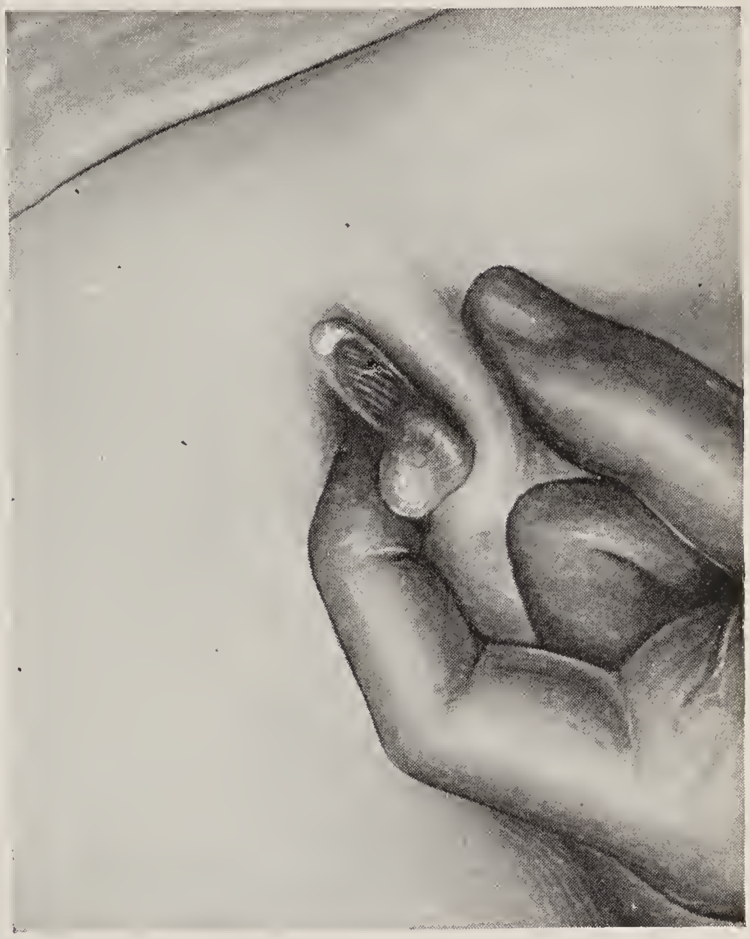

Fig. 43. Anal Fissure. The index-finger in the anal canal has drawn outwards a polypus at the inner end of the fissure. The fibres of the external sphincter are seen forming the floor of the fissure, also the 'sentinel pile' at its outer end.

FOR IRRITABLE ULCER OF THE ANAL CANAL

This is usually single and is situated dorsally about three-quarters of an inch above the margin of the anus.

The operation consists in forcible dilation of the sphincter under general anæsthesia, followed by either curettage or the application of undiluted carbolic or nitric acid to the ulcer. If the ulcer be lying behind an anal valve, this must be snipped off to prevent the lodgment of fæces. If enlarged papillæ of Morgagni be present, they should be removed. The after-treatment consists in keeping the bowels easily moved, and the application of calomel ointment before and after the bowels act. It may be necessary to touch the ulcer again with carbolic acid; this may be done without an anæsthetic.

FOR ANAL OR RECTAL ABSCESS

Under gas anæsthesia, *an anal abscess* should be opened in a line radiating from the anus, and another incision should be made across this at right angles, thus converting it into a crucial incision. The sphincter is then well dilated. The cavity of the abscess is washed out and lightly packed with cotton-wool soaked in 1–1,000 sublimate solution. This treatment is carried out two or three times daily.

For *ischio-rectal abscess* the treatment is the same as for anal abscess, but care must be taken to introduce the finger and break down all loculi; the cavity should be lightly packed with gauze to prevent the skin uniting by first intention, and hot fomentations should be frequently applied.

A *pelvic-rectal abscess* may be due to disease in the rectum itself, such as carcinoma or stricture, or to disease of neighboring organs, viz. the prostate or seminal vesicles, or to pelvic cellulitis or periproctitis; it is usually situated in front of the bowel.

The patient should be given a general anæsthetic, and the abscess opened freely through the perineum or ischio-rectal fossa, according to the situation of the abscess. The left index-finger should be placed in the bowel, where it will detect the induration due to the abscess and also any condition within the bowel which may have caused the abscess. If the pus be deep seated, it should be explored for with closed forceps, which can be opened when the pus has been found, thus enlarging the aperture. The abscess cavity is then explored with another finger, all loculi investigated, and their walls broken down to form one cavity. The abscess is well irrigated with an antiseptic solution and free drainage provided for by rubber tubes. When the bowels act, care should be taken to keep the wound protected by dressings held in place by strapping.

FOR TUBERCULOUS DISEASE ABOUT THE ANUS

EXCISION OF THE TUBERCULOUS AREA

Indications. Where the patient's general health and powers of repair are good, and where the disease is of the hypertrophic papillomatous variety (see Fig. 44), and where ulceration is limited in extent and would not necessitate too extensive a removal of the skin.

Operation. The bowels should be well cleared before operation, the parts well washed, and an antiseptic fomentation applied. When anæsthetized, the patient is turned into the semi-prone position, lying on the side to be operated upon. The parts are again washed and scrubbed with an antiseptic solution. With a sharp scalpel, two semilunar incisions passing through the whole thickness of the skin are made to enclose the diseased area, which is cleanly dissected away from the underlying tissues. If possible, the long axis of the wound should radiate from the anus. All bleeding points are seized with clip-forceps and twisted. When bleeding is quite arrested, the wound is completely closed with interrupted silkworm-gut sutures, the ends of which are cut rather long. The skin edges of the wound must be undercut if necessary,

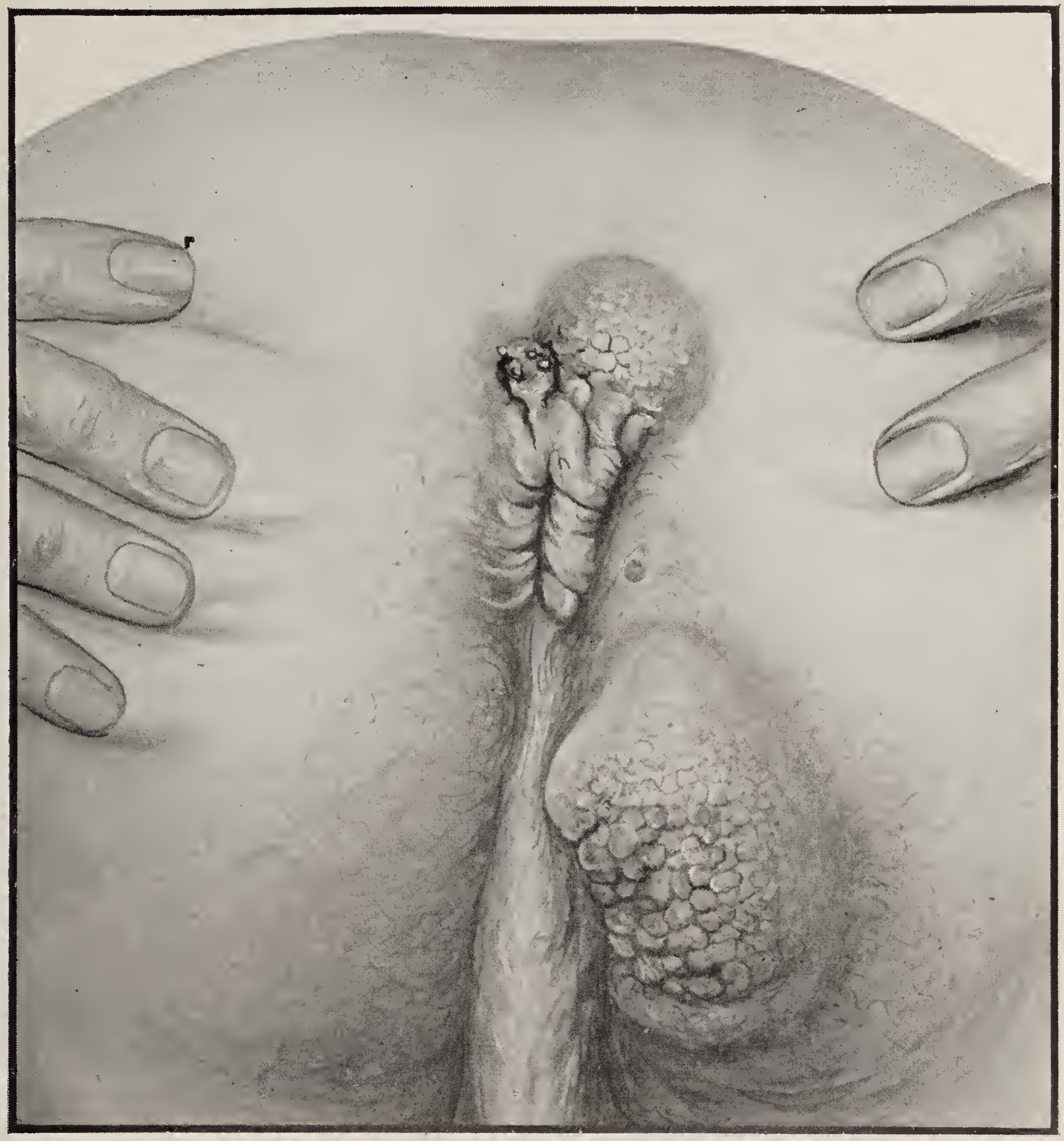

Fig. 44. Hypertrophic Form of Tuberculous Disease about the Anus. The patches are oval in shape, dusky red in colour, raised above the surrounding skin, and gradually shelving towards the circumference. The surface is covered with papillomatous-looking elevations between which there is ulceration.

to enable them to be brought together without tension. Any other diseased areas are treated in the same way. The parts should be well dried, dusted with aristol, and a collodion dressing applied.

Local anæsthesia may possibly be employed for this and the next operation.

After-treatment. The patient should remain in the recumbent position, but should, if possible, have the usual open-air treatment for a tuberculous subject.

The bowels should remain confined as long as the patient is comfortable, say six or seven days, in the hope that the wounds will have healed by first intention before the bowels act. If they have been well cleared previously to the operation, there will probably not be much difficulty about this. The administration of 10 grains of salol in powder or cachet twice daily will be of much use in the prevention of flatulence.

If the wounds do not heal by first intention, or it has not been possible at the operation to close the wound, a subsequent plastic operation for the prevention of undue contraction may be required.

Results. Where the disease has been entirely removed the results are very satisfactory.

CURETTING TUBERCULOUS ANAL ULCERS

Indications. Where the ulcers are multiple and disseminated, or where the diseased area is too extensive for excision (see Fig. 45).

Operation. The patient is anæsthetized and placed in the lithotomy position.

The lesions are then thoroughly scraped with a sharp spoon, well irrigated with an antiseptic solution, and dried. Paquelin's cautery at a red heat is then carefully applied to each wound. If the disease has spread into the anal canal, the sphincter must be dilated and the same treatment carried out.

Eucalyptus ointment, or one consisting of aristol ʒi to the ounce of vaseline, should be applied, then a piece of boric lint, wool, and a T-bandage.

After-treatment. The same position and hygienic treatment must be adopted as after the last operation. The bowels may, however, be opened in two or three days' time, when the wounds must be carefully washed with cotton-wool wrung out of an antiseptic solution, well irrigated in addition, and the same kind of dressings reapplied. Subsequently the bowels may be opened every day or other day. Every possible means must be taken to increase the patient's resisting power to the tubercle bacillus.

Results. These are uncertain. Some cases require curetting a number of times and are very difficult to cure; in others, where it is purely a local tuberculosis, a favourable result is obtained.

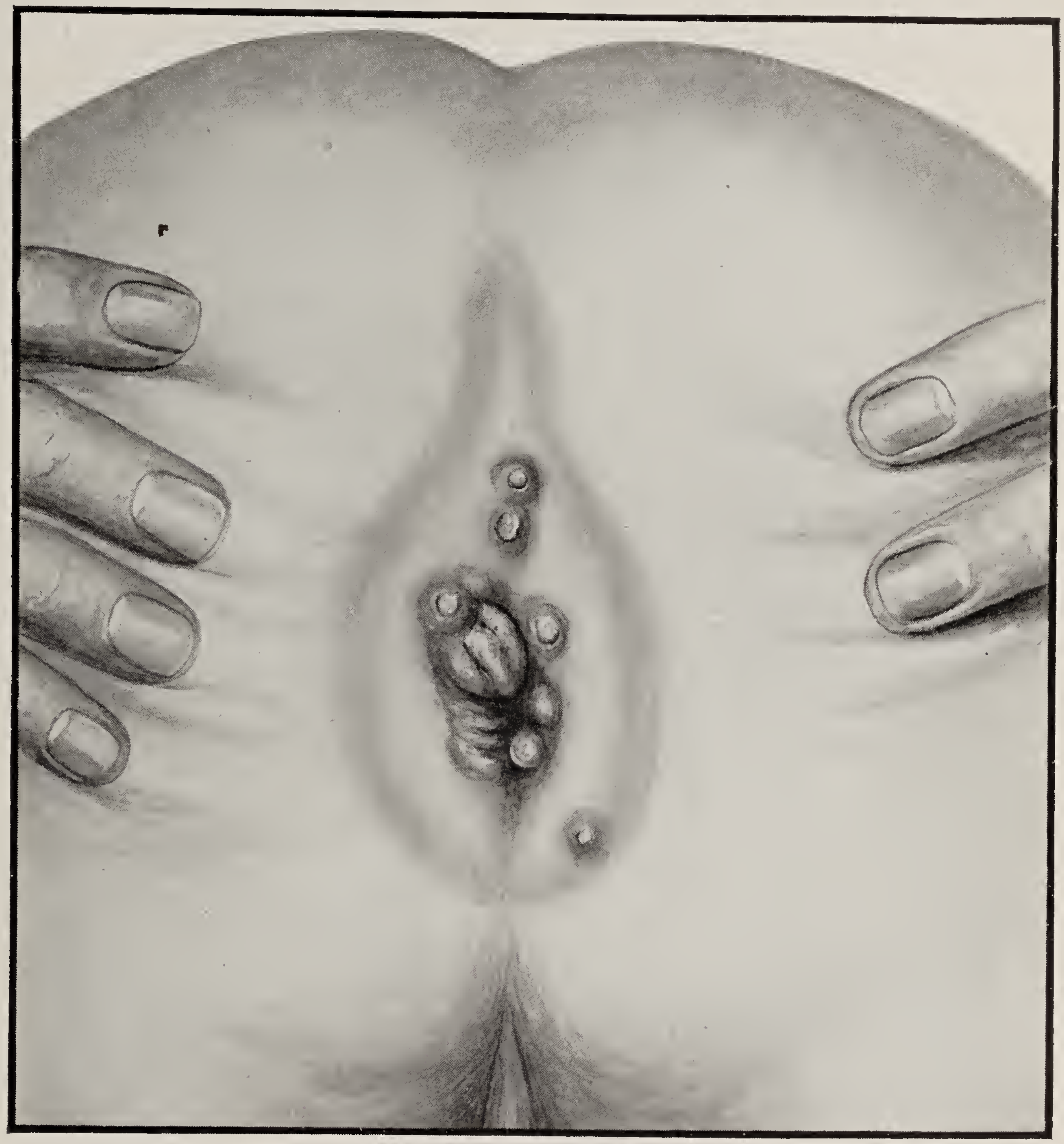

Fig. 45. Tuberculous Ulcers in the Anal Region. The ulcers are somewhat circular in form, with undermined and overhanging edges and a yellowish floor.

PERINEAL EXPLORATION FOR IMPERFORATE ANUS

Indications. In all cases of imperforate anus, except where the rectum opens into the vagina or vulva by an opening large enough to allow a free escape of meconium.

Operation. The child should be enveloped in cotton-wool, anæsthetized by ether given by the open method, and the bladder emptied.

It is then placed in the lithotomy position with the pelvis raised on a firm cushion.

If the anus be closed by a membrane only, this will bulge when the child cries or when pressure is made upon the abdomen.

The membrane must be carefully divided by a crucial incision and the bowel washed out with warm water.

When the anus is imperforate or absent, and the bowel ends blindly at some distance above, an incision is made at the site of the anus, exactly in the middle line, and enlarged backwards as may be necessary, and an attempt is made to find the rectum and free it sufficiently to bring it down to the skin incision, where it should be sutured all round. It is then opened and washed out, and afterwards the mucous membrane is sutured to the skin margin, some of the sutures including the whole thickness of the bowel to prevent retraction.

If the bowel be not easily found, the dissection must be carefully deepened and at the same time carried forwards. According to Keith's opinion after his investigations of the specimens in the museums of London, it is physically possible to bring the rectum down to the perineum in 95% of the cases. If the rectum be not found terminating at the site of the proctodæum, it will be found terminating at, or perforating, the prostate or the lower end of the vagina; if not there, then at the base of the prostate or upper part of the vagina.

The search for the bowel will be aided by the right index-finger in the wound, frequently feeling for fluctuation, while pressure is made on the child's abdomen. A trochar and canula should never be used in the search for the bowel; careful dissection alone should be employed.

If at a depth of 2 inches the bowel has not been found, inguinal colostomy (see Vol. II, p. 700) should be performed. In some cases the rectum has been found afterwards and brought down to the anal skin margin.

Another alternative is to deliberately open the peritoneum below by careful dissection upwards and somewhat forwards, and then search for the bowel, when it might be possible to find its blind extremity, bring it down, and fix it at or near the skin margin, the peritoneum being closed with catgut before the bowel is sutured and opened.

If a fistula which is not of sufficient size to allow of the proper escape of meconium opens into the vagina or vulva, a bent probe or director should be passed backwards through the fistula and, if possible, made to impinge on the perineum at the normal site of the anus. It is there cut down upon, and the bowel found and sutured to the skin margin.

When a fistula opens into the median raphé in the male, the same procedure should be adopted.

Dangers. There is great danger that in using a trochar and canula, Douglas's pouch, the bladder, or some coil of bowel may be perforated or the coats of the rectum may be separated. This may also take place unless great care is used with the knife. The child is in a very unfavourable condition for operation, which must not be unduly prolonged.

After-treatment. When the bowel is sutured to the margin of the anus, all that is required is to keep the part clean, and later on to gently insert the lubricated little finger for a time to prevent contraction.

Where after opening the bowel it has been impossible to attach it to the skin, troublesome contraction will follow; this must be met by the insertion of a bougie for several hours daily. If, in spite of this, the passage becomes too narrow, it must be enlarged by a backward incision, made with a blunt-pointed straight bistoury.

Results. Keith states that the prognosis is bad; an imperforate condition of the rectum appears to react unfavourably on the economy of the child even before birth, and death commonly occurs, even if the rectum be opened early. The exception is in the case of females, where the rectum opens within the vulva. In all cases hypertrophy and dilatation of the rectum follows, even if an anus be successfully established.

CHAPTER III

OPERATIONS FOR FISTULA IN ANO AND RECTAL FISTULÆ: REMOVAL OF RECTAL POLYPI AND TUBERCULOUS MUCOUS MEMBRANE

OPERATIONS FOR FISTULA IN ANO

WHEN an abscess forms in the anal or rectal region and bursts externally, and the track fails to close, it constitutes a *blind external fistula;* when there is an opening in the skin and another into the bowel, it is a *complete fistula.* Cases occur in which the internal orifice is so low down, that it can scarcely be considered to be in the bowel at all; these may be called *complete external fistulæ.* There may be two openings into the bowel, one high up, the other lown down, with a simple track connecting them and no opening in the skin; this would be a *complete internal fistula.* A *horseshoe fistula* has one or more external orifices on either side of the anus, and an internal one in the middle line behind. The outer openings may be equidistant from the anus, or they may be at different distances, and placed wide from the anal orifice far out on the buttocks; and in exceptional cases a track will also run up at right angles to the main dorsal track, either outside or inside the muscular coat of the rectum, and if it opens into the bowel, the opening may be 2 or 3 inches above the anus. In such cases there will be two internal openings.

FIG. 46. STEEL FISTULA DIRECTOR.

In most cases of fistula, the internal opening is single; it is within one inch of the anus; is situated dorsally in the middle line, and between the two sphincters. There seems to be a definite relation between the external and internal orifices of a fistula; for fistulæ having their external aperture situated behind a plane passing transversely through the anus, usually have their internal orifices in the middle line posteriorly, and therefore have a somewhat curved or semi-circular course. This variety is called a *semi-horseshoe fistula,* the exception being the simple fistula, which is the outcome of a dorsal fissure. Those which are anterior to this supposed plane generally have their internal openings immediately opposite the external and on the same side, thus constituting the simplest form of complete fistula.

Indications. Practically all cases of fistula require operation, the only exception being that of a recently formed blind external fistula, which may, though rarely, be induced to heal by injections of silver nitrate (grs. xx ad ℥ i) applied by means of a small sinus syringe. As it is desirable that the bowels should not be moved for three or four days after an operation for fistula, some aperient, *e.g.* castor oil, should be given on the day but one before the operation, and a copious warm-water enema on the evening before, to make sure that the rectum is empty.

Operation. For the performance of the operation the patient should be placed on a table, lying on the side on which the fistula exists, in the semi-prone position; in the case of a horseshoe fistula and in that of perineal fistulæ, the lithotomy position is the more convenient. A general anæsthetic is most advisable, though simple fistulæ may be slit up painlessly under local infiltration anæsthesia (see Vol. I, p. 140). A probe-pointed director is passed along the track of the fistula as far as its internal opening (see Fig. 47). If this be near the anus, the forefinger of the other hand is introduced into the bowel, and the end of the director is easily made to protrude from the anus (see Fig. 48). The parts lying upon the director are then divided with a sharp bistoury. In cases of small complete fistulæ running either under or through the external sphincter, the slitting up of the fistula should be supplemented either by forcible dilatation or by complete division of the sphincter, that the part may be put more completely at rest. Great care must be taken to divide the sphincter at right angles to the direction of its fibres, or the muscle may be permanently weakened, and more or less incontinence result. Granulations or indurated tissue should be scraped or dissected away and a careful search made with a probe for any other tracks. If a bud of granulation presents after curetting, that spot probably leads to a branch and must be explored and dealt with in the same way. When the external orifice is puckered and the skin drawn in, it is advantageous to incise the floor and outer orifice of the fistula with a blunt-pointed bistoury, thus relieving all tension, and where the walls of the fistula are much indurated, one or more incisions should be made into the hardened tissues radiating from the first cut. All overlapping edges of skin and mucous membrane must be removed with scissors. When the internal orifice is an inch and a half or more from the anus, the sphincter should be forcibly dilated and a duck-bill speculum inserted; a probe-pointed director is then passed through the fistula and an incision made on to the director from within the bowel. Great care must be exercised to keep to the fistulous track, as the point of the director is easily pushed through its wall, and this leads to the slitting up of healthy tissues and perhaps the escape of a portion of the fistula from division. If a sinus extends up above the internal aperture beneath mucous membrane only, it should be laid freely open; if it extends outside the muscular coat of the bowel, it is best not to divide it, but to be contented with careful curetting, especially if its division involves that of the internal sphincter, for when both sphincters are divided incontinence may follow. If the fistula be found to lead down to dead bone, most commonly the coccyx, after the fistula has been dealt with as above, the bone must be laid bare, the periosteum stripped off with a raspatory, and the diseased portion removed with sequestrum forceps or gouge.

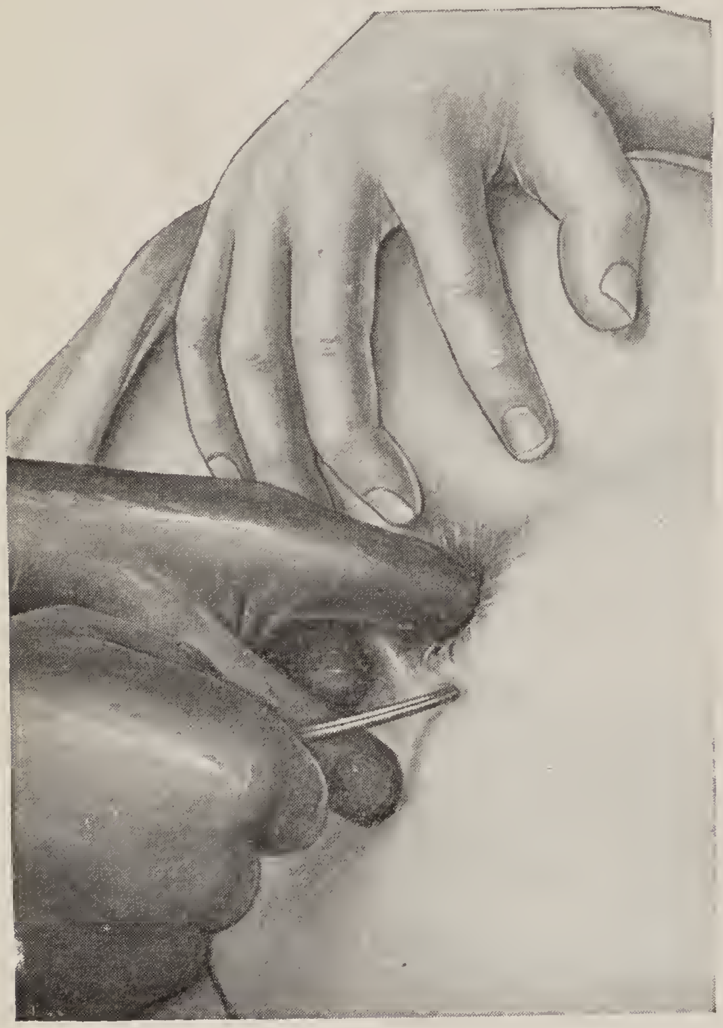

Fig. 47. Searching for the Internal Orifice of an Anal Fistula. The left index-finger is in the bowel; the probe-pointed director is held in the right hand.

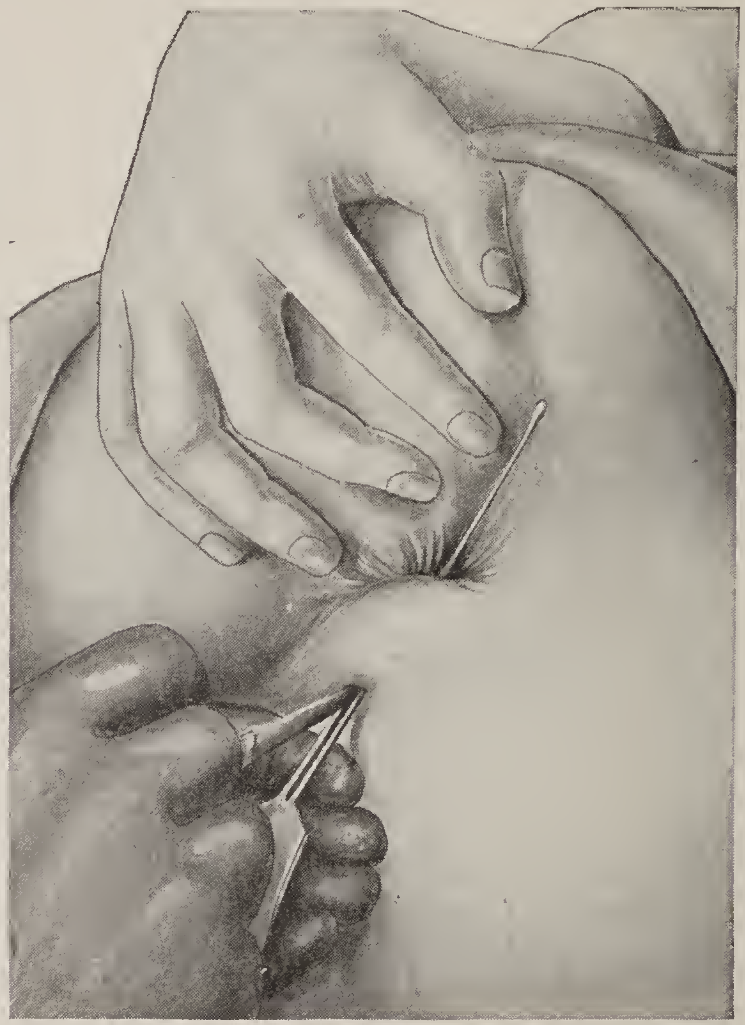

Fig. 48. An Anal Fistula being laid open. The probe-pointed director, which is held in the left hand, has been passed along the track of the fistula and its point brought out of the anus. A bistoury held in the right hand is dividing the tissues overlying the director.

There is seldom much hæmorrhage; if any large vessel has been divided it should be ligatured. If there be profuse general oozing, the wound may be plugged with a strip of gauze, or a hollow vulcanite rectal tube may be inserted, and a long piece of absorbent cotton-wool, or gauze, introduced between the wound and the tube.

After the operation a little absorbent cotton-wool, wrung out in a 1 in 1,000 perchloride of mercury solution, should be gently placed between the surfaces of the wound. A pad of the same material is then applied to the anal region, and, over this, one or more pads of gamgee tissue, the whole being retained in position by means of a T-bandage.

Blind external fistula. A spot can generally be found where only a thin layer of tissue intervenes between the finger in the bowel and the point of the director in the track of the fistula. Through this thin layer the point of the director should be carefully pushed and the operation completed in the usual way.

Blind internal fistula. If there be a hard swelling in the anal region, an incision should be made into it, and if a probe-pointed director can then be passed into the bowel, the operation is completed as before. If there be no external signs such as swelling or induration, a well-curved probe-pointed director should be introduced into the bowel, guided by the finger, and an endeavour made to pass the director through the internal opening; if this be unsuccessful, a speculum may be used and the director passed under the guidance of the eye. The point can then be felt subcutaneously and cut down upon, and the remainder of the operation completed.

Horseshoe fistula. In operating upon a horseshoe fistula (see Fig. 49, A), it is, first of all, most necessary to recognize it, *i.e.* to understand its conformation, for a casual observer might think he had two separate fistulæ to deal with, and operate accordingly. Even were he to recognize that he was dealing with a horseshoe fistula, if he followed the usual plan, he would slit up first one sinus and then the other; thus dividing the sphincter in two places, and obliquely through its fibres, proceedings generally fraught with dire consequences to the patient (see Fig. 49, B).

If this fistula can be laid open in such a way as to entail only one division of the sphincter, and that at right angles to its fibres, there will be a minimum amount of risk of subsequent incontinence. It can be done in either of the following ways (see Fig. 49, C): (1) First pass a probe-pointed director through the internal aperture, and on its point incise the skin in the middle line behind; now push the director through, and slit up. Secondly, slit up the lateral sinuses on directors passed in at the external openings and brought out at the dorsal incision. These lateral sinuses may take either a straight, curved, or even rectangular direction. The first incision will have divided the sphincter, but the other two will only have divided tissue external to it. (2) Should the external apertures be so placed that a straight line drawn from the one to the other would pass behind the anus (see Fig. 49), the steps of the operation could be reversed, and a director be passed in at one external orifice and out at the other, and the tissues divided; or if the external openings be so situated that a probe passed in at one cannot be passed out at the other, pass the director along the track to the mid-line behind the anus, and incise the tissues on to its point. Then insert the director through the external opening on the other side and pass it along the fistulous track and out of the wound already made behind the anus. Now pass the director from the wound in the middle line into the bowel, through the internal opening, and slit up the tissues with the included sphincter. In this way the incisions will be found to be more or less T-shaped, the stem corresponding to the dorsal cut. In cases where a sinus extends upwards at right angles to the main track (see p. 96),

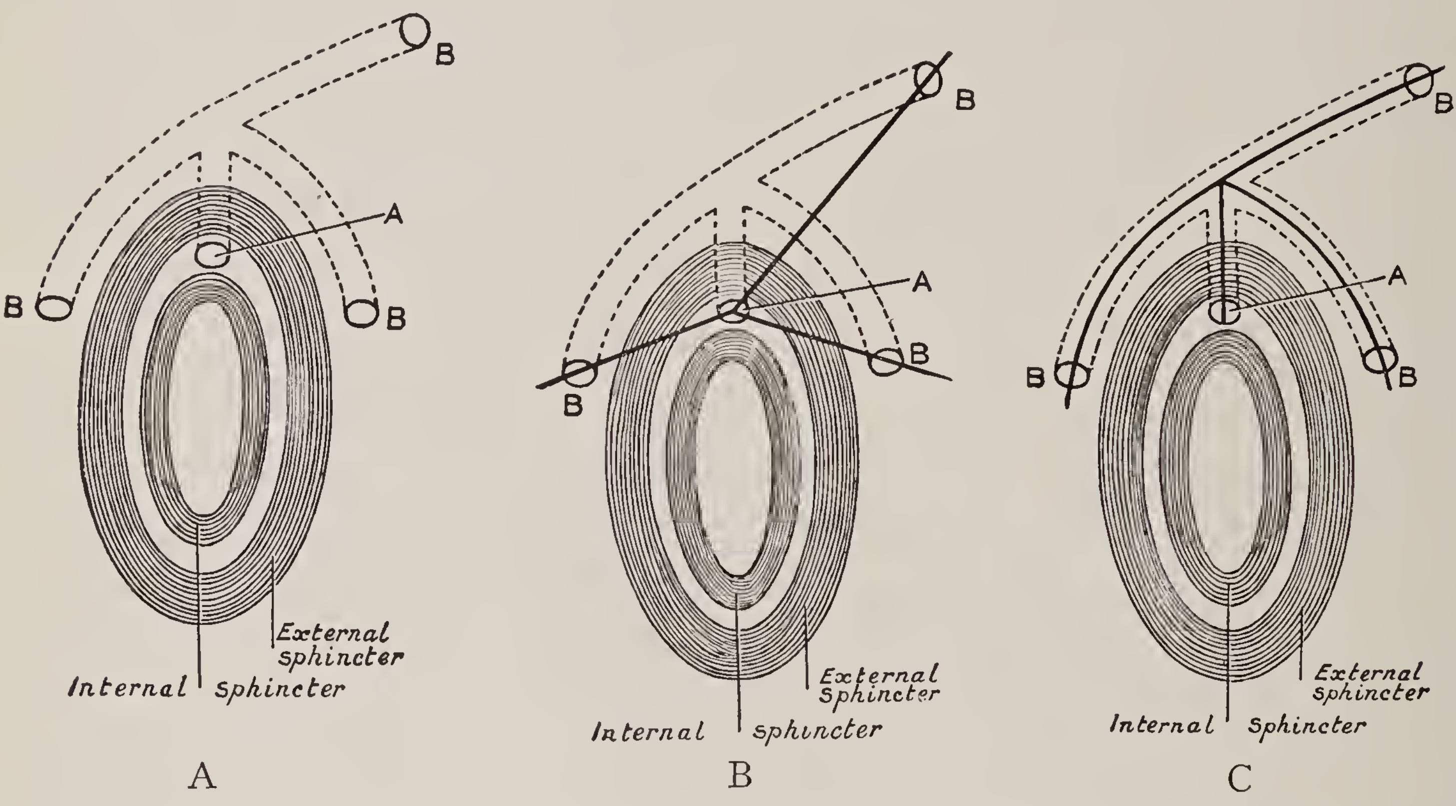

Fig. 49. Horseshoe Fistula. A. *Diagram of a typical horeshoe fistula with one branch.* A, Opening into the bowel, through its posterior wall; B, B, B, External openings in the skin. The dotted lines indicate the track of the fistula.

B. *Diagram showing the wrong method of operating in horseshoe fistula.* A great deal of the fistulous tract has escaped division, and the external sphincter has been divided obliquely and in three places.

C. *Diagram showing the correct method of operating in horeshoe fistula.* The whole of the fistulous tract has been laid open, and the external sphincter has only been divided once and then at right angles to the direction of its fibres. The thick lines in B and C represent the incisions in the operations.

it is usually outside the muscular coat of the bowel; and as its division into the bowel would involve the internal sphincter, it is best to content oneself with dilating and curetting it. Later it will probably require stimulation by injection of nitrate of silver (grs. 10 to 60 to the ounce). Should the track be merely a submucous one, however, there is no objection to laying it open into the bowel.

These remarks apply equally to that minor variety of horseshoe fistula which is called the *semi-horseshoe fistula*. In these cases, the patient is placed on the side on which the external opening exists; an ordinary grooved director is passed through this opening, along the track, to a point behind the anus in the middle line; this track is then laid open. A probe-pointed director is then passed forward, from the end of the track, through the internal opening, and the sphincter and the superjacent structures are divided in the mid-dorsal line.

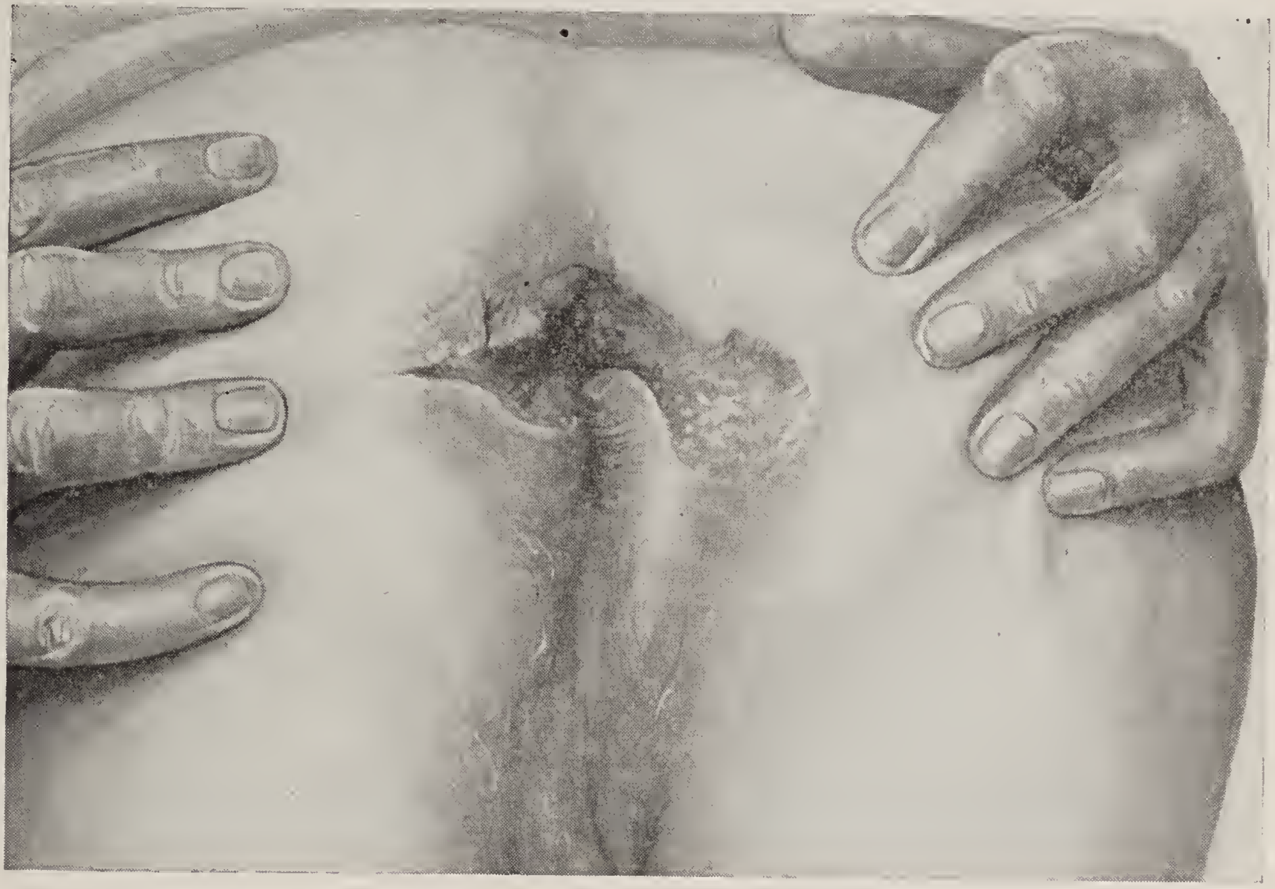

FIG. 50. HORSESHOE FISTULA FOURTEEN DAYS AFTER OPERATION.

The operation above described may be done *à deux temps,* and if the fistula necessitates many and deep incisions, this modification will be found very advantageous. The first operation will consist in laying open all the outlying sinuses, and when these are nearly healed, it will only be necessary to make the dorsal cut through the sphincter; in other words, this second operation will be merely one for an ordinary dorsal fistula. This method, although usually necessitating two operations, has these advantages: (1) The wound after the first operation can be kept free of all fæcal contamination, as there has been no interference with the bowel; (2) in some cases it lessens the gravity of the operation; (3) there is a chance, remote though it may be, that the fistula will heal without any division of the sphincter.

Internal horseshoe or circumferential fistula. In this variety the arms of the horseshoe run forwards beneath the mucous membrane: the posterior opening is situated in the mucous membrane in the mid-line.

A probe-pointed director is introduced through the orifice in the mucous membrane posteriorly and made to project behind the sphincter; in this position it lies deep to the external sphincter. The point of the director is now cut down upon and pushed through the opening. The included tissues are now incised, the external sphincter of course being divided. The object of this is to put the part at rest. The submucous lateral sinuses are now curetted as far as possible, and after a few days are treated by an injection of a solution of silver nitrate, 10 to 30 grs. to the ounce, applied by means of a sinus syringe. This should be repeated about twice a week.

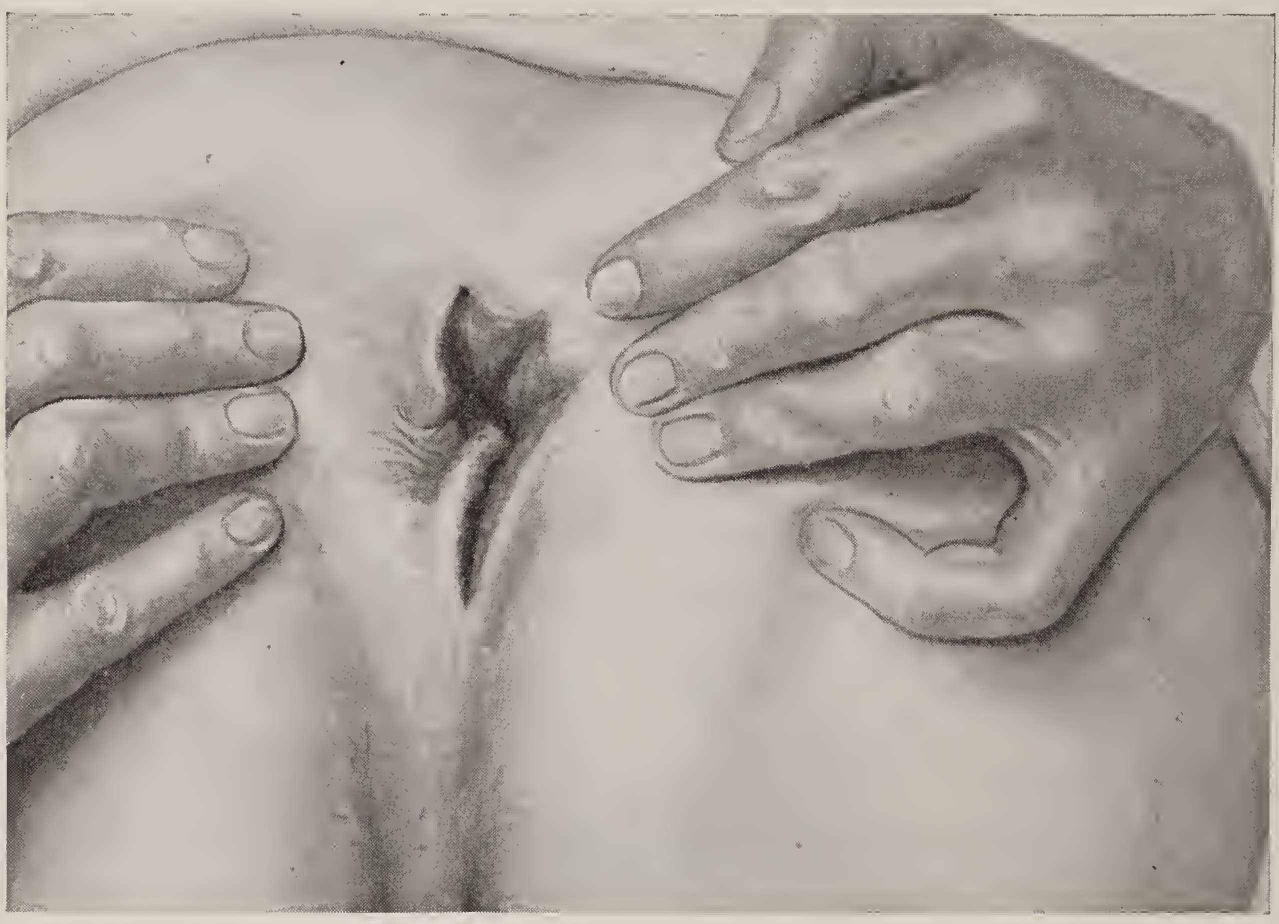

FIG. 51. SEMI-HORSESHOE FISTULA SEVEN DAYS AFTER OPERATION.

Fistula due to tuberculous disease. The hair about the part is often unusually long and perhaps curly, the ischio-rectal fossæ are sunken in, owing to the absence of fat, and the sphincter is weak. The skin around the external orifice is bluish and often considerably undermined; the internal orifice may be large and the mucous membrane around it also undermined, and the discharge is thin and watery. The question of operation and its scope must be decided by the local and general condition of the patient. If the patient be the subject of phthisis which is quiescent, and his powers of repair appear to be satisfactory, after a general examination, an attempt should be made to cure the fistula. If the disease in the lung be active and advancing, the local condition had better be left alone, or only so much done as will provide for drainage and so relieve pain. It is most important to see that the patient is put under the most favourable hygienic and dietetic conditions, and there need be no fear that the cure of the fistula will lead to increased activity of the disease in the lung.

All tuberculous granulation-tissue should be well scraped away, and if possible the sphincter should not be incised at all. The patient should not be kept in bed more than two or three days, but should lie on a couch, and if possible in the open air. Stimulant and astringent preparations may be required locally, to assist healing of the wound, such as red lotion and balasm of Peru. Many surgeons use insufflation of iodoform before applying the dressings. Aristol is an iodine preparation which, used in the same way, is probably just as effective and much more pleasant to use.

After-treatment. The dressing in the wound may be allowed to remain until it comes away when the bowels act for the first time, but if the wound be large and much packing has been inserted, boric fomentations should be applied in order to loosen it, and it may then be gradually removed, the remnant of it coming away with the first action of the bowels. Afterwards, in ordinary cases, the daily insertion of a little strip of cotton-wool (see p. 99) will suffice to keep the edges of the wound from uniting; but in more severe cases, and where deeper packing is necessary, strips of sterile gauze are to be preferred to cotton-wool. Let me here draw the attention of the reader to the best method of carrying out the dressing after the operation in an ordinary case of fistula. The finger, coated with vaseline, should first be passed into the rectum, and, whilst *in situ,* the dressing should be inserted along the finger, which thus acts as a guide. The dressing should be carried up, along the entire length of the wound, by means of a probe-pointed director, passing from the wound, at its upper limit, into the bowel, thereby ensuring that the margins of the wound are kept separate. Moreover, this method of dressing is much less painful than where, following the usual plan, a ‘plug,’ as it is often called, is stuffed into the wound without the directing finger. I confess that I have an aversion to the term ‘plugging,’ as applied to the dressing of wounds after an operation for fistula. For it is a well-known fact that plugging a wound retards its healing; and I have several times seen a wound which has refused to heal, although the surgeon has assured me that he had carefully plugged it every day, heal rapidly when only a light dressing has been substituted.

On the fourth day after operation, when the bowels have been moved, the wound should be syringed with a warm solution of either sublimate (1 in 2,000), lysoform (1 in 60), boric acid (1 in 40), or Condy's fluid (1 in 100), to remove any fæcal matter, and the syringing should be repeated after each action of the bowels. A fresh dressing should be inserted at least once daily. If the healing process goes on satisfactorily, no other dressing will be required; but if the granulations are sluggish, it will be well to stimulate the track of the wound by the use of lunar caustic, red lotion,[1] balsalm of Peru, or compound tincture of benzoin. Under favourable circumstances, and provided that it has not been necessary to make a very deep incision, complete healing may be expected in about three weeks. For severe cases, six weeks to two months may be required. The patient should be kept at rest, and not allowed to walk about, until the wound has far advanced in the healing process. Fistulæ due to the presence of a foreign body, *e.g.* a fish-bone, heal up much more quickly after operation than those connected with constitutional disorders.

Resection and immediate suture. In some cases, after complete removal of the disease and irrigation of the wound, an attempt may be made to completely close the wound and get healing by first intention. Such cases are those where the patient's powers of repair are good, and especially those where it has been possible to dissect away the fistulous tract. This will only be possible in straight fistulæ, *i.e.* those in which the track has a more or less straight course between the external and internal orifices. The sphincter is first well dilated and paralysed, the fistula slit up, curetted, and if possible entirely dissected out, and the wound well irrigated with an antiseptic solution. The deeper parts of the wound are then closed by buried sutures of iodized catgut and the mucous membrane of the bowel is closed by sutures of chromic catgut. The skin and subjacent parts of the wound are closed with interrupted silkworm-gut sutures. The bowels should be opened by a dose of laxative medicine and an olive-oil enema in four or five days after operation, and afterwards they should be moved daily or every other day, care being taken to keep the motions quite soft to avoid strain on the sutures. Cases of tuberculous and of ordinary fistula have been treated in this way and have healed by first intention, and even if the whole wound does not heal at first, a considerable saving of time may result. On the other hand, the chances of a radical cure are not nearly so certain as when the wound is dressed and made to granulate up from the bottom. There is great difficulty in keeping wounds in this region aseptic, and if this is not done, some part, or the whole of the wound, will break down and suppurate. This is most likely to take place in the deeper parts of the wound and practically the original condition is re-established, thus necessitating a second operation. If the whole of the wound breaks down it is not in a favourable condition for healing, as the skin edges will not have been sufficiently cut away, and there will be much difficulty in preventing their uniting and producing ‘ tunnelling ’ of the wound. Therefore I cannot recommend this method, although it has been somewhat strongly advocated of recent years.

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[1] Sulphate of zinc, 2 grains; compound tincture of lavender, 15 minims; water to 1 fl. oz.

When there is a sinus about the lower end of the sacrum or coccyx which does not lead to bare bone or communicate with the bowel, the sinus must be laid open and curetted, great care being taken not to touch the bone. All overhanging edges of skin must be removed with scissors, and the wound must be carefully packed with sterile cotton-wool and thoroughly dabbed with a swab soaked with sublimate lotion. In this way the wool, which fills all the interstices of the wound, becomes impregnated with the antiseptic; outside a pad is placed and held in place by a T-bandage. Boric fomentations are applied on the second day and continued till all the original dressing has come away. Dressing must be lightly inserted into the wound daily to ensure its healing from the bottom.

OPERATIONS FOR RECTAL FISTULÆ

Recto-urethral fistula. A stricture of the urethra is generally present and is the usual cause of this condition. The stricture must be cured by dilatation or urethrotomy, and this alone may suffice to close the fistula. If further measures be required, the operation is the same as for recto-vesical fistula.

Recto-vesical fistula. When the condition is due to some non-malignant process, the anus should be well dilated to obtain a good view of the rectal orifice of the fistula. If the opening be small, the actual cautery should be applied to the entire track, and possibly a posterior proctotomy may be needed to give sufficient room. If there has been much loss of substance, causing a large opening, the edges of the opening should be carefully pared while the patient is in the semi-prone position; he should then be placed in the lithotomy position and the rectum separated from the prostate and base of the bladder, through a transverse perineal incision. The opening into the bladder is closed by mattress sutures of fine silk or chromic catgut. The opening into the bowel is next closed in the same way. The sutures must avoid the mucous coat in both cases. The perineal wound is partly closed with superficial and deep sutures, and a drain is left down to the neighbourhood of the repaired fistula; this may generally be removed in about twenty-four hours. The external sphinceter should be divided, as the paralysis produced by the preliminary dilatation of the anus will be too transient to ensure the abolition of all resistance to the passage of fæces.

After the operation the patient should be placed in the prone position and maintained in it as far as possible; a catheter is kept in the bladder for the first forty-eight hours. The bowels should be opened on the fourth or fifth day.

Recto-vaginal fistula. When the fistula is due to malignant disease, excision of the growth may be possible; otherwise colostomy will give relief. In inflammatory and traumatic cases, ulceration and stricture, if present, should first be cured or greatly improved, and subsequently a plastic operation should be performed. According to the conditions present, one of the following methods may be used: (1) Repair of the fistula through the rectum. (2) Repair through the vagina. (3) A combination of these two. (4) Complete division of the perineal body, including the fistula, followed by perineorrhaphy. (5) Separation of the rectum from the vagina by a transverse perineal incision, with repair of the fistula through that incision. Whichever method be adopted, except No. 4, it is most important to ensure that the sphincter offers no resistance to the escape of the contents of the bowel; its complete division is therefore advised.

REMOVAL OF RECTAL POLYPI

The small glandular polypi found in children can often be seized in forceps and twisted round and round till they come away. Other polypi, when within reach, may be removed after dilating the anus and dragging the tumour down. Its base is then encircled with a tight ligature and the tumour cut off, leaving a good stump to prevent slipping of the ligature. If the base be broad, it should be transfixed by a needle carrying a double ligature. The ligature is divided near the eye of the needle, interlocked, and each half tied tightly. The bowels should be kept at rest for three or four days, and the patient should not move about as usual till after the separation of the ligature.

When the polypus is situated too high up to be removed through the dilated anus, it may perhaps be removed by means of a snare introduced through a proctoscopic tube. When this is impossible, a posterior proctotomy will be required through a parasacral incision, with removal of the coccyx, and possibly also a piece of the sacrum; such cases, however, are very rare, as the vast majority of polypi are attached to the rectal wall within 4 inches of the anus.

EXCISION OF TUBERCULOUS RECTAL MUCOUS MEMBRANE

Indications. Tuberculous ulceration of the lower two inches of the rectal mucous membrane, which has not improved after curetting and cauterization.

Operation. The patient is placed in the lithotomy position, the sphincter dilated, the whole circumference of the diseased mucous membrane excised, and the cut edge brought down and sutured to the margin of the anus. The details of the operation are identical with those employed in Whitehead's operation for piles (see p. 128).

After-treatment. The anus should be irrigated twice daily with an antiseptic solution, dried and dusted with aristol, and every care taken to obtain healing by first intention—a result not often attained. The bowels should be opened on the fourth day. The patient should be kept lying down till the parts have healed, but the day after operation should be carried into the open air, if possible, and the usual general treatment for tuberculosis carried out.

Results. Very satisfactory when the disease is local—much time is saved and the patient is freed from his disease.

CHAPTER IV

OPERATIONS FOR PROLAPSE AND FOR HÆMORRHOIDS

OPERATIONS FOR PROLAPSE

OF MUCOUS MEMBRANE ONLY

Linear cauterization. *Indications.* In those rare instances in children where palliative measures are not successful, the best treatment is by linear cauterization with Paquelin's cautery at a dull red heat.

Operation. It is performed as follows: The patient is anæsthetized and placed in the lithotomy position. The prolapse may be cauterized before it has been returned or afterwards; in the latter case an anal speculum will be required. In the case of a child the fine point of the cautery, at a dull red heat, is drawn along a line extending from the base to the apex of the prolapse. Three or four similar lines are drawn on the mucous membrane, parallel with the first and equidistant from each other, and the prolapsed mucous membrane is returned into the bowel. If the anal orifice be unduly patulous, as is usually the case, the cautery-point should be drawn to the anal orifice, and on each side should be made to burn deeply enough to divide some of the superficial fibres of the external sphincter. A little cotton-wool smeared with vaseline or eucalyptus ointment is then introduced into the bowel.

After-treatment. The patient should be kept in the recumbent position for fourteen days. The bowels should be opened on the fourth day; a few hours previously, some ounces of olive oil should be introduced into the rectum. The patient, if a child, should be placed on his side for the action of the bowels, and it is often advisable for the nurse to draw the anus a little to one side during the act; this is done by slight traction on one buttock. If the patient be an adult he should lie on his back. These positions should be enforced at each action of the bowels for at least three weeks. In adults a large cautery-point will be used and broader eschars made; in all cases, care must be taken not to perforate the mucous membrane. If a second operation be found necessary, the cautery should be applied to the spaces between the cicatrices resulting from the first operation.

Removal of prolapsed mucous membrane. *Indications.* In adults, when there is a partial prolapse of mucous membrane, often mistaken for prolapsed hæmorrhoids.

Operation. The removal may be effected either by ligaturing portions of it, as is done when operating for piles by the ligature (Salmon's operation), or by the clamp and cautery, or by Whitehead's method of removing the pile-bearing area.

The choice of these methods will depend upon the extent of the prolapse. If only part of the circumference protrudes, the ligature or clamp and cautery should be chosen, but of the two I prefer the former. In prolapse of the whole of the circumference of the mucous membrane Whitehead's operation for piles yields excellent results (see p. 128), Indeed I think it far more suited to this condition than for that for which it was originally devised, viz. internal hæmorrhoids, because in this condition the stitches are not nearly so likely to cut out, as there is practically no tension, whereas when done for hæmorrhoids this is considerable.

Excision of portions of skin and mucous membrane (Cheyne and Burghard). Where the anus in adults is very patulous, four diamond-shaped portions of skin and mucous membrane may be excised. A triangular-shaped portion of each is removed; the bases of the triangles meet at the margin of the anus. The sizes of the portions removed will depend on the size of the prolapse and the tonicity of the sphincter; generally more mucous membrane than skin will be removed. The wounds are closed so as to make longitudinal cicatrices parallel to the long axis of the bowel. Chromic catgut, which will hold for three weeks in muscle, should be used for the mucous membrane, and horsehair or fine silkworm-gut for the skin. The after-treatment is the same as after linear cauterization.

OF THE BOWEL-WALL (PROCIDENTIA RECTI)

Rectopexy. *Indications.* This operation is only suitable for a minor degree of procidentia, and is more likely to be followed by relapse than either complete excision or ventro-fixation.

Operation. The patient is placed in the semi-prone position. An incision is made from the sacro-coccygeal articulation to within 1 inch of the anus and is deepened through the levator ani till the bowel is reached; its posterior surface is cleared of fat and the bowel is drawn upwards in the direction of the sacrum. Four silkworm-gut sutures are inserted horizontally and about three-quarters of an inch apart, through the posterior rectal wall, just avoiding the mucous membrane. Then, by means of a large curved needle, the free ends of these sutures are brought out through the skin, on either side of the lower sacrum and coccyx, about 1 inch apart. The ends of the two upper sutures are tied across a pad of gauze placed over the sacrum. The levator ani is repaired with buried chromic catgut sutures and the dorsal incision is closed with silkworm-gut. The two lower sutures are now tied, like the upper two, over a pad of gauze. These anchoring sutures are removed after ten to fourteen days. Buried sutures of chromic catgut may be used to sling up the bowel to the tissues about the sacrum, to facilitate which removal of the coccyx may be necessary.

Ventro-fixation or sigmoidopexy. *Indications.* In cases where the bowel is reducible and prolapse of all the coats is frequent.

Operation. The abdomen is opened through the left rectus sheath. The peritoneum is divided and a strip of it, about 1 inch wide and 2 inches long, is removed on either side from the edges of the lower part of the wound. The sigmoid colon is then drawn up, care being taken to render it taut at its lower end. It is retained in apposition to the bared fascia transversalis, from which the peritoneum has been removed, by means of about four sutures of fine silk, which are passed first through the fascia on one side, then through a longitudinal band, and then through the fascia on the other side, and then tied. The peritoneum of the upper part of the wound is closed, and the rest of the wound sutured in layers.

After-treatment. The foot of the bed should be kept raised for about fourteen days. The patient should be kept recumbent for three weeks, and during the whole of this time must not be allowed to sit up to have the bowels moved, but this must always take place in the recumbent position. The bowels should be assisted to act in three days' time after the operation by means of mild laxatives and enemata, the patient being warned against any straining down. The movements should take place every two or three days afterwards.

Results. For a time these are very satisfactory, but there is a tendency for the adhesions to stretch and for the prolapse to recur.

One of my patients suffered with dragging pains in the hypogastric region after this operation, but time gradually ameliorated these. It has occurred to me that this might have been caused by tension on the fascia transversalis and peritoneum; in future cases I should be inclined to pass the anchoring sutures through the rectus muscle and its anterior sheath, seeing that in this situation the posterior sheath is wanting. At all events this method of suture would be less likely to be followed by a recurrence of the prolapse.

In some cases of 'procidentia,' when a considerable prolapse of mucous membrane precedes the descent of all the coats, and when the sphincter has lost its power of contraction, it is a good plan to combine linear cauterization with ventro-fixation, either at one operation, or in two stages with an interval of a week or two between them.

Complete excision (Mikulicz). *Indications.* As this is a severe operation, it should be reserved for cases where other methods have failed, for cases where gangrene threatens, and where the prolapsed bowel is irreducible.

Operation. The bowels having been well cleared out previously, the patient is anæsthetized and placed in the lithotomy position, with the pelvis well raised on a cushion. This is done to allow the small intestine to slip up into the abdomen out of the way. The prolapse is drawn down as far as possible; it is then seized by two volsella forceps and held in this position by assistants. After the intestine has been dragged down, it is surgically cleaned and dried with sterile gauze. An incision is then made across the mucous membrane upon the anterior surface of the gut, *i.e.* through the outer layer of intestine close to the margin of the anus. This is carefully carried through the entire thickness of the intestine, all bleeding points being tied with catgut as encountered, until the peritoneal cavity is opened all round. When this has been done the bowel is drawn down as far as it will come easily, and the serous membrane of the divided outer layer of bowel is sutured to the peritoneum of the inner intestinal tube by a number of fine silk mattress sutures, the number of which will vary according to the size of the prolapse. The protruding portion of the bowel is then cut off by means of short snips with scissors, and the cut end is sutured to the margin of the anus as it is divided. The muscular and mucous coats are sutured separately by chromic catgut sutures, the ends of the latter being left long in order to steady the parts and prevent their retraction while the operation on the other portion of the circumference is being done. All bleeding points must be twisted or ligatured at once; the vessels of any size will be found posteriorly in the mesorectum.

After completing the excision, a fine continuous suture of catgut should be applied round the entire circumference if the edges of the mucous membrane be not in accurate apposition. The ends of the sutures should then be cut short and the area of operation dusted with a powder such as aristol or boric acid. A good-sized drainage tube is introduced into the rectum, and the parts round it dressed with sterilized gauze.

Difficulties and dangers. There may be a pouch of peritoneum between the layers of the prolapsed bowel anteriorly, which may contain a loop of herniated bowel or omentum; these may easily be wounded or allowed to prolapse if the bowel be carelessly divided. The tendency to prolapse, however, is minimized by having the patient's pelvis well raised.

When the bowel is divided, hæmorrhage may be very free, but this is obviated by only making very small cuts and securing the vessels at once. As the peritoneum is opened there is a risk of peritonitis, so that great care must be taken that the bowel is surgically clean before the operation is commenced. There must be no tension on the sutures or they will cut out prematurely and immediate union will fail, with likelihood of ulceration taking place and subsequent formation of stricture.

After-treatment. The patient should be kept in the recumbent position for three weeks, and during the whole of this time the bowels must act in this position. The bowels should be kept confined by opium for seven days, and before they are allowed to act an olive-oil enema should be given to soften fæcal material and diminish the strain on the sutures. The parts should be irrigated and cleansed twice daily with an antiseptic solution and dusted with aristol or boric acid, and fresh dressing applied. Light diet should be given while the bowels are confined, and 10 grains of salol given twice daily to prevent the formation of gas in the intestines.

Results. The results are generally very satisfactory; the prolapse is cured, and the patient regains control.

MOSCHCOWITZ OPERATION

Moschcowitz describes his operation as follows:

Median abdominal incision, extending from the symphysis pubis to the umbilicus. After opening the abdomen, the patient is placed in an extreme Trendelenburg position. Every one with any experience knows the depth of the cul-de-sac of Douglas in a normal case, but he will be intensely surprised at its depth in cases of prolapse of the rectum; in fact, it extends several inches beyond the anus, as one can readily convince himself. The subsequent steps vary according to the sex of the patient; I shall describe an operation in the female sex.

Pagenstecher or silk sutures are passed circularly around the cul-de-sac of Douglas, and tied. The lowermost suture is placed about one inch above the inferior extremity of the cul-de-sac; similar sutures, six to eight in number, are passed at intervals, and persisted in as long as the peritoneum comes together until practically the entire pouch of Douglas is obliterated.

It is advisable, and I always try to include in my suture the pelvic fascia, particularly that part which covers the levator ani; how often I really succeed in doing this I am not in a position to state.

(Theoretically it would be better to split the peritoneum in the depth of the cul-de-sac, and to suture the fascia first. I have attempted to do so in one case, but found the procedure so difficult that I abandoned it.)

When the sutures reach the region of the supravaginal portion of the cervix and body of the uterus, the sutures are anchored to these structures.

When approaching the rectum, the sutures coming from the sides of the pelvis catch the serosa covering it, in firm and close stitches.

This is done in order to prevent the possible formation of a hernia; in addition, these lateral sutures also materially aid in fixing the rectum to the sacrum and coccyx.

There are two structures which should be avoided, namely, the ureters and internal iliac vessels. The former can be marked by introducing ureteral catheters; the pulsation of the latter serves as a guide; neither of these structures have thus far caused me any embarrassment.

In older women the uterus is stitched to the anterior abdominal wall.

No fixation of the intestine, viz. sigmoid flexure, is undertaken, as it is superfluous.

Suture of the abdominal wall in layers.

The after-treatment is simple. I neither constipate nor move the bowels of the patients. The bowels will generally move of their own accord in less than a week. I have found that most of the patients require catheterization. In other particulars the after-treatment is that of any laparotomy.

OPERATIONS FOR EXTERNAL HÆMORRHOIDS

Incision of thrombosed piles. *Indications.* Where the blood-clot is of recent formation, or where suppuration has taken place.

Operation. This should be done at once, as there is nothing to be gained by delay, and the relief to the pain and inconvenience is immediate.

The part should be cleansed with 1–40 carbolic lotion and 10% cocaine solution applied on cotton-wool for ten minutes, or, if preferred, nitrous oxide gas may be administered.

The patient should be in the lateral semi-prone position, on the same side as the pile, and the upper buttock held upwards by an assistant. The point of a sharp-pointed curved bistoury is then inserted into the innermost extremity of the pile, which is rapidly transfixed and opened in a line radiating from the anus. The incision is a very superficial one, only dividing the vein-wall and the overlying skin. The black blood-clot, which is now in view, is seized with dissecting forceps and gently removed. Hæmorrhage will be trifling or absent, being prevented by a small portion of clot which remains behind. A small cotton-wool swab wrung out in 1–2,000 sublimate solution should now be applied externally, and outside this a pad of cotton-wool, the whole being held in place by a T-bandage. Some pressure should be used to aim at healing by first intention.

The operation is extremely easy and simple and presents no difficulties or dangers of any sort.

After-treatment. Rest in the recumbent position for two days is advisable but not essential, unless there is any tendency to hæmorrhage. The parts should be cleansed with an antiseptic lotion two or three times daily and the same kind of dressing reapplied. Vaseline should be inserted just within the anus by the finger before each action of the bowel in order to protect the little wound.

Where suppuration has taken place fomentations must be applied, as after the opening of an ordinary anal abscess.

Results. The patient is at once relieved and the formation of a tag of external skin is prevented.

Excision of external piles. *Indications.* In thrombosed piles of long standing when the thrombus is adherent and cannot be evacuated by a simple incision. Where external tags are either producing or keeping up pruritus ani, or are subject to recurring attacks of inflammation, or where annoyance is caused to the patient by their presence interfering with proper cleansing of the part after stool.

Operation. The patient having been prepared in the usual way and anæsthetized, each tag in turn is grasped with tag-forceps and cut off with strong scissors. Care must be taken not to cut away too much skin, or stricture will be caused; also the scissors must be so applied that the wounds radiate from the anus and leave an area of skin between each wound. Several small vessels will probably require a ligature. I do not advocate the suture of these wounds, as without it the results are excellent, and with it there is always a risk of stitch abscess.

OPERATIONS FOR INTERNAL HÆMORRHOIDS

Indications. Operative interference is not necessary in all cases of hæmorrhoids. For instance, if the piles only protrude at stool and return spontaneously after the act and are unaccompanied by much hæmorrhage, palliative treatment usually suffices; but when, on the other hand, hæmorrhage is excessive or the piles have to be replaced by the patient or surgeon, or when they are a source of annoyance owing to their protrusion during walking, such cases undoubtedly require operative interference.

Before operating for piles it is well to ascertain if the patient has any respiratory or other trouble which might entail a sitting posture after the operation, as it is a most unfavourable one for these cases. Again, a cough may be a source of much distress, owing to the jarring which it gives to the anus. The surgeon must also ascertain if there be any obstruction to micturition, such as stone, enlarged prostate, or stricture. Any one of these may have been the cause of the piles and to operate first on them would be to put the cart before the horse. Stricture and malignant disease higher up the bowel must be excluded. Retention of urine frequently follows operations for piles, and if the presence of a stricture prevented the passage of a catheter, a deal of suffering and inconvenience might be caused.

REMOVAL BY LIGATURE (SALMON'S OPERATION)

It is desirable that the bowels should be cleared by aperients for two or three days prior to operation if possible. Failing this, castor oil should be given about 4 p.m. on the day before operation and the bowel well washed out with warm water early the following morning, if the operation is to be done, say, about 9.30 a.m. Castor oil is the best aperient for this purpose, as its secondary astringent effect avoids dribbling from the bowel above during the operation, which is likely to take place if such a drug as sulphate of magnesia be used; care must of course be taken that the enema has been got rid of before the operation. On the evening before operation the parts about the anus should be well washed and shaved, if necessary, and a sublimate compress applied. Of course, in this as in all operations, the usual precautions against sepsis are adopted: sterilization of instruments, hands, ligatures, towels, etc., and

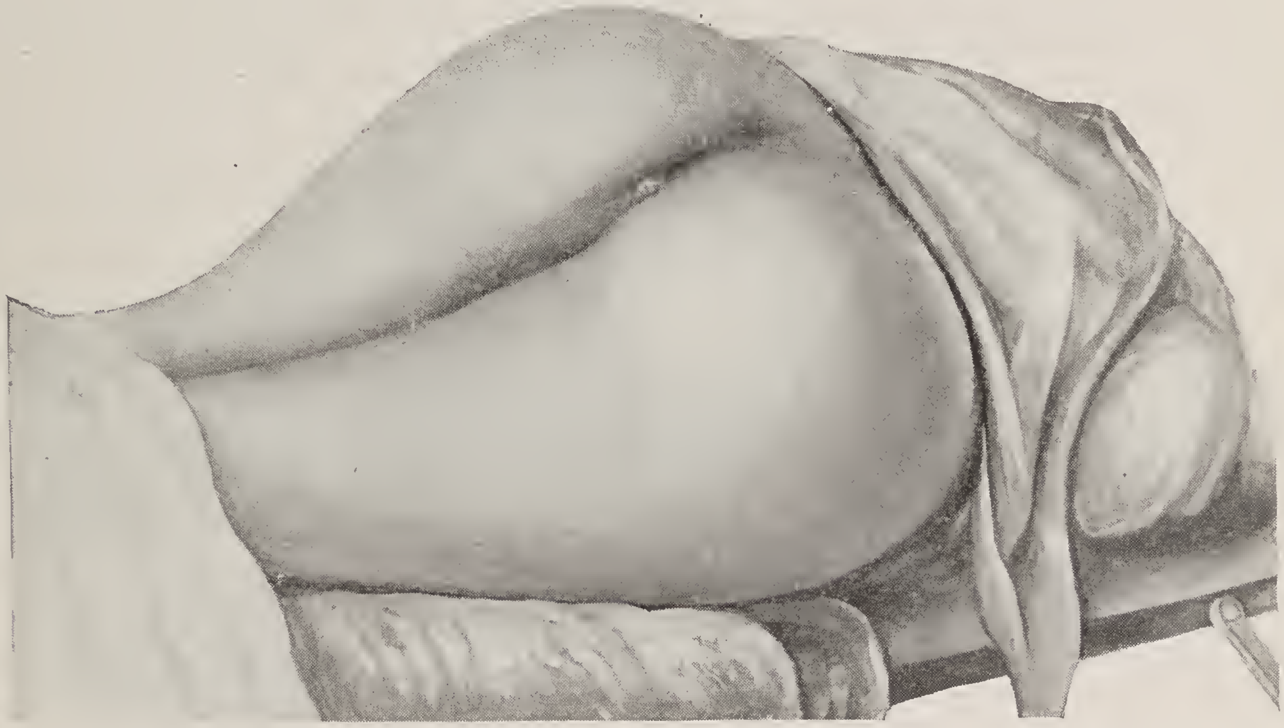

FIG. 52. PATIENT IN POSITION FOR THE REMOVAL OF HÆMORRHOIDS BY SALMON'S OPERATION.

preparation of the anal region; though naturally it is impossible to render the rectum sterile.

Operation. The patient, fully anæsthetized, is placed in the right lateral prone position, with the knees well drawn up to the abdomen and the buttocks exposed to a good light. The surgeon stands or sits facing the buttocks; his assistant stands opposite to him on the same side of the table and raises the left buttock with his right hand. The surgeon now introduces his index-finger, smeared with vaseline, into the bowel and rapidly examines its entire circumference as high up as possible, to determine the presence or absence of any other lesion. The index-finger of the other hand is then inserted, and forcible dilatation of the anus is carried out, by separating the fingers gradually with some force; this should be continued till the resistance of the sphincter is overcome. In most females, and in all feeble subjects, but little force is necessary, and one must be on one's guard not to rupture the sphincter entirely; which may easily be done, its fibres giving way suddenly, with the formation of a hæmatoma. In females particularly is this likely to take place in front and to cause permanent loss of power in the sphincters of the anus and vagina. On the other hand, in some patients

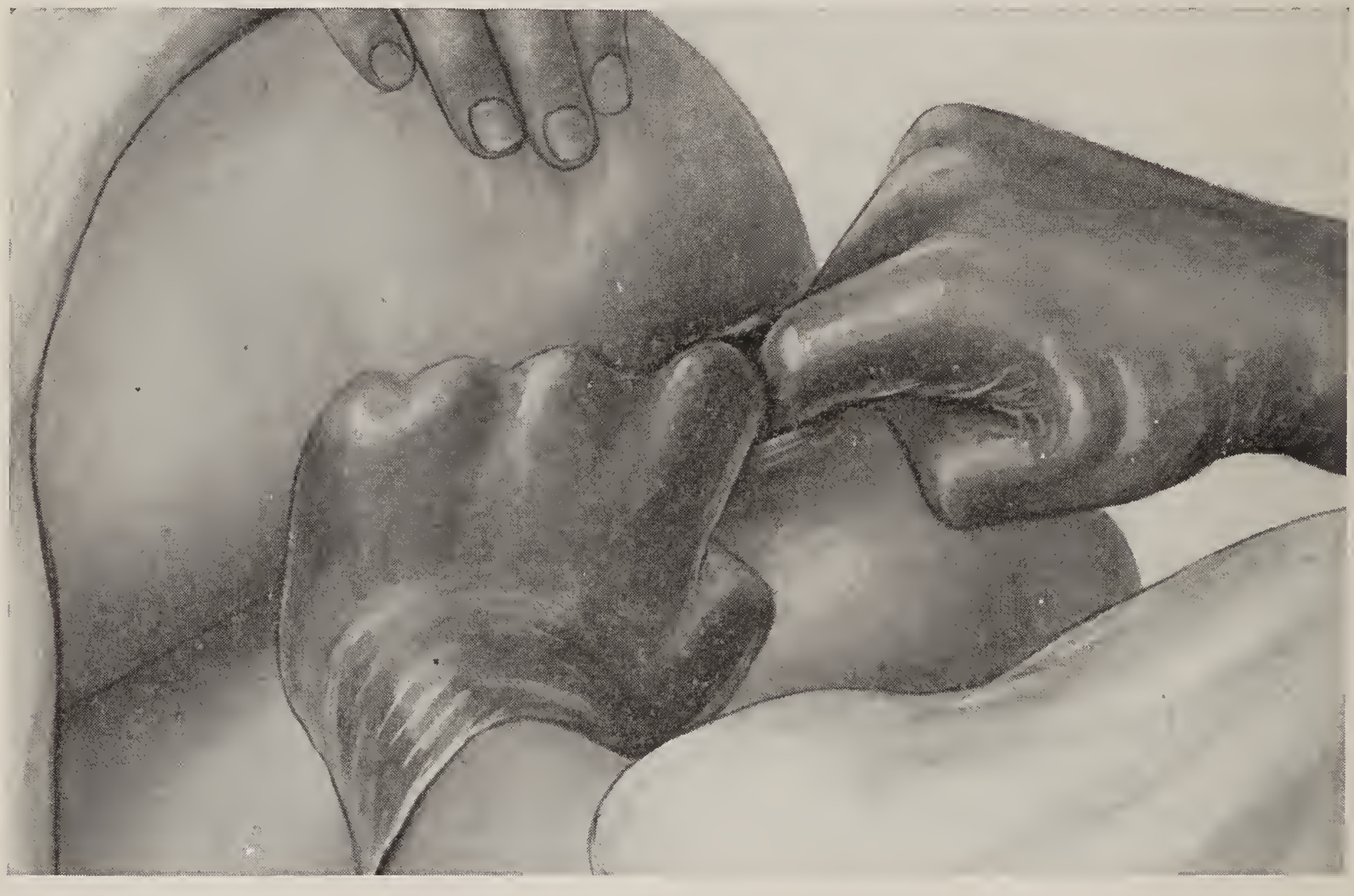

Fig. 53. Ligature Operation for Hæmorrhoids. *First stage.* Forcible dilatation of the anus. With very resistant sphincters two fingers or the thumbs of each hand may be used.

the sphincter may be unusually strong and resisting, requiring much strength and some time to overcome its resistance. In such cases the thumbs may be used or two fingers of each hand.

The piles and lower part of the rectum are swabbed with cotton-wool soaked in 1–1,000 sublimate solution. Each hæmorrhoid is now seized with clip forceps and drawn outwards, giving an excellent view of the interior of the bowel, so that it is next to impossible to overlook even a very small pile. If the usual three piles, viz. the right and left lateral and the perineal, only are present, I operate on the right first, as it is lower, and the bleeding from it will not obscure the others, passing on then to the perineal and left lateral; but if secondary piles are present, I operate on these first, in order that they may not be forgotten. Starting, then, with the right lateral, the surgeon takes the forceps with which it is secured in his left hand, and raising the pile, marks the sulcus between it and the external pile if one is present, but if not, the line of junction between the skin and mucous membrane. Here, at the external circumference of the pile, an incision is made with a strong pair of scissors (Salmon's) with one cut, parallel to the long

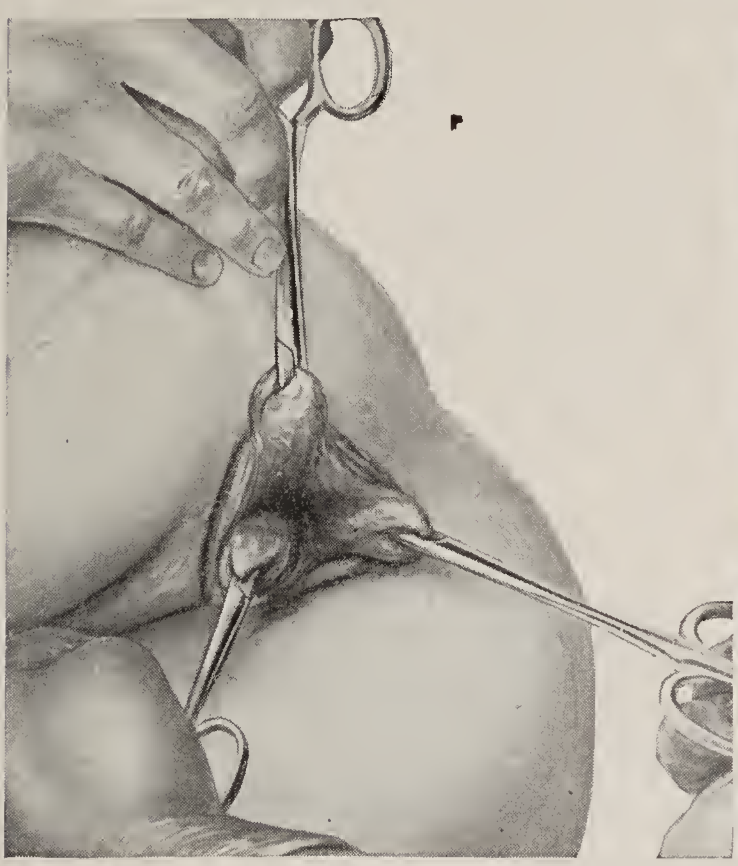

FIG 54. LIGATURE OPERATION FOR HÆMORRHOIDS. *Second stage.* Each hæmorrhoid is seized with clip-forceps and drawn outwards, so that an excellent view of the interior of the bowel is obtained and even a small pile is not overlooked.

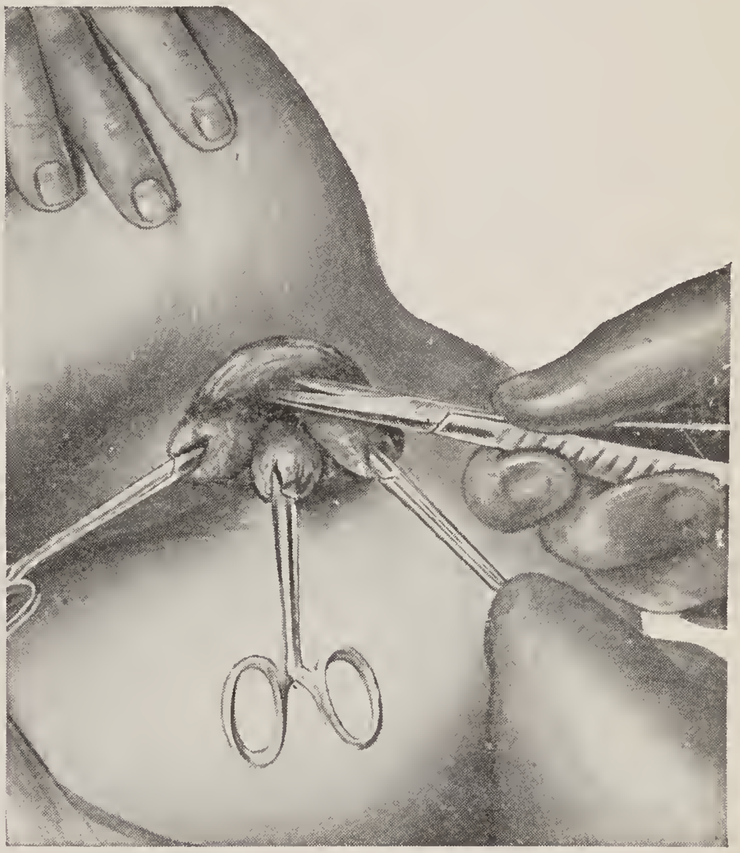

FIG. 55. LIGATURE OPERATION FOR HÆMORRHOIDS. *Third stage.* The pile is being separated from the bowel-wall by a cut made with Salmon's scissors at the junction of the skin and mucous membrane.

axis of the bowel; this incision varies in depth from half an inch to an inch, according to the size of the pile; which is thus severed from the bowel, except at its upper part, which may now be called its pedicle. An oblique cut should now be made with the scissors on each side of the pile to narrow this pedicle. These cuts start in the incision already made and pass obliquely inwards towards the vessels which enter the pile from above, and lie just under the mucous membrane. The pile and its pedicle are now pear-shaped. The object of this manœuvre is to minimize the removal of mucous membrane above, and prevent the liability to stricture at a part where, without this precaution, some contraction of the lumen of the bowel is not uncommon. The assistant now takes the forceps with his left hand, whilst his right is engaged in supporting the other pair of forceps and lifting up the buttock. Whilst the assistant lifts up the pile, the surgeon lays a strong No. 10 plaited silk ligature round the pedicle and ties it tightly and carefully, with the knot on the uncut mucous membrane, *i.e.* towards the lumen of the bowel. When all the piles have been thus treated, any bleeding points should be searched for, by lifting them off the several wounds. It is quite usual to find several small arterioles, branches of the in-

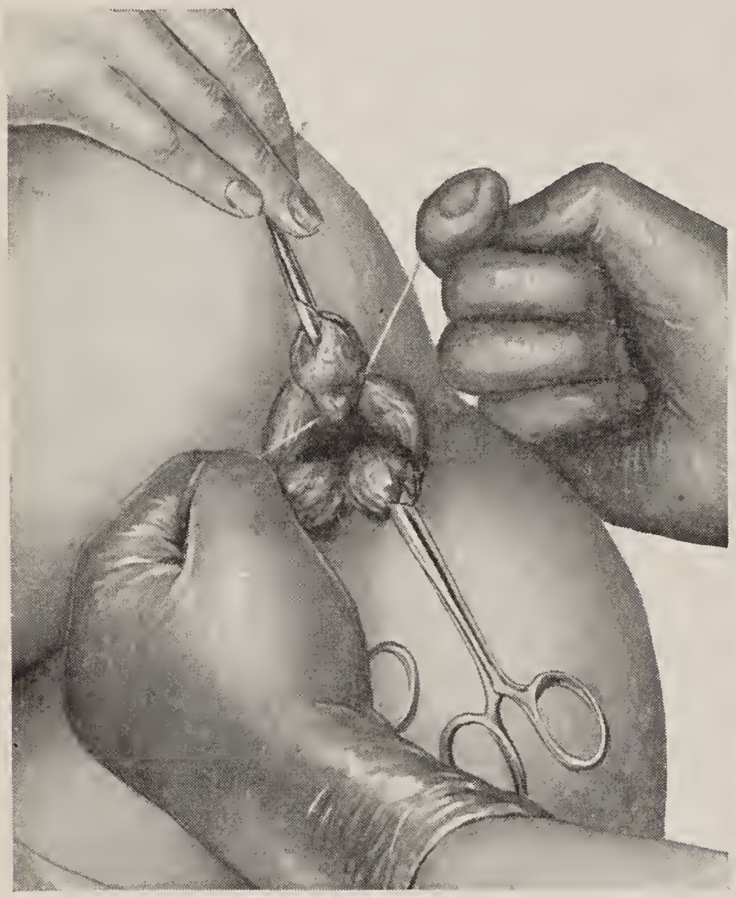

Fig. 56. Ligature Operation for Hæmorrhoids. *Fourth stage.* A pile is being drawn down and a strong ligature has been laid in the groove made by the scissors.

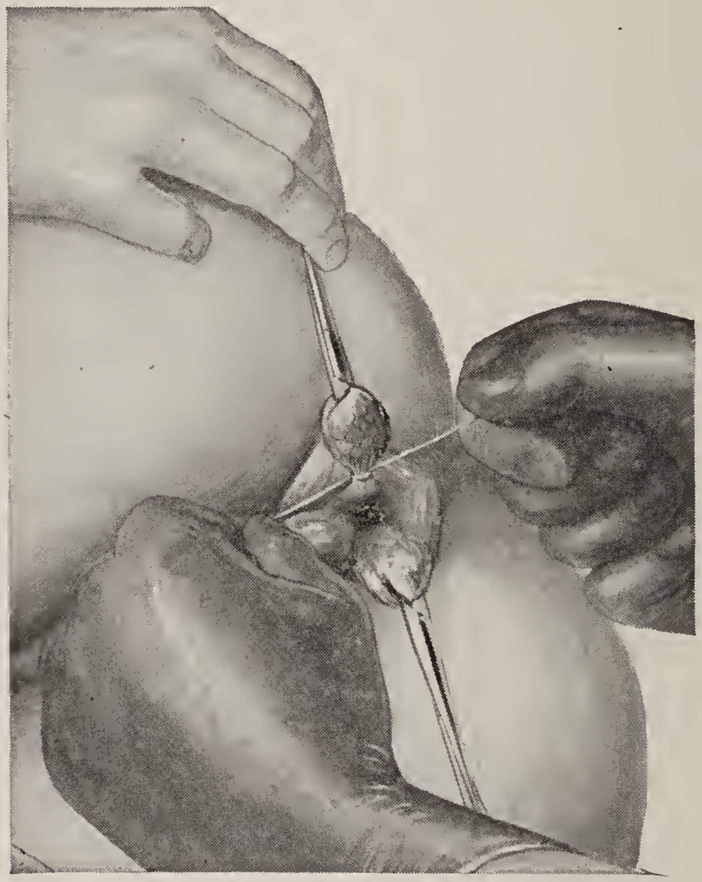

Fig. 57. Ligature Operation for Hæmorrhoids. *Fifth stage.* The ligature has been tied round the pedicle of the pile. The knot is towards the lumen of the bowel.

ferior hæmorrhoidal artery, which run into the pile transversely, and will require tying. The ligatured piles may now be returned into the bowel. They should not be cut off, or at most only their apices; this prevents slipping of the ligatures and grave trouble from hæmorrhage. I generally use No. 10 plaited silk ligature for most piles; it should be so strong as to be unbreakable, yet not too thick. I use No. 4 silk for the smaller piles, and for vessels No. 1 twisted.

External tags or piles are now removed with tag-forceps and scissors. The surgeon must bear in mind the necessity of moderation in this part of the operation, as he is removing skin and may easily cause troublesome contraction of the anus. Here also there is usually a small vessel which will require a ligature in each resulting wound. The ends of the pile ligatures may be cut off, leaving about 3 inches of them protruding from the anus. The index-finger is inserted well beyond any constriction caused by the ligatured piles. This constriction may be excessive, when the piles are numerous or very large; but, however well marked, it always gives way to steady pressure with the finger, which also tends to prevent any subsequent contraction. In such cases it is absolutely necessary to pass the finger a number of times, after the ligatures have come away, to prevent a stricture resulting. This trouble will rarely result if the precaution has been observed of cutting the piles pear-shaped as already described.

A small 1/3-inch rubber tube, with a large eye at its distal end, and a ligature threaded to its proximal end as an anchor, is now inserted into the bowel. The projecting end of the tube is packed round with sterilized gauze, or with swabs wrung out of sublimate solution (1–2,000); a stronger solution may irritate the skin. A cotton-wool pad is placed over all and is kept in position by a T-bandage firmly applied. The use of the rubber tube has the following advantages: It enables the patient to get rid of flatus, and so avoid the discomfort from its retention, of which so many patients complain when no tube is used. It reveals any hæmorrhage which may be taking place; so that concealed hæmorrhage can hardly occur. Its very presence tends to prevent oozing. Through it, 3 or 4 ounces of olive oil are injected shortly before the first action of the bowels. The tube being in position, the patient is not subjected to the pain which may accompany the passage of any nozzle or tube for this purpose.

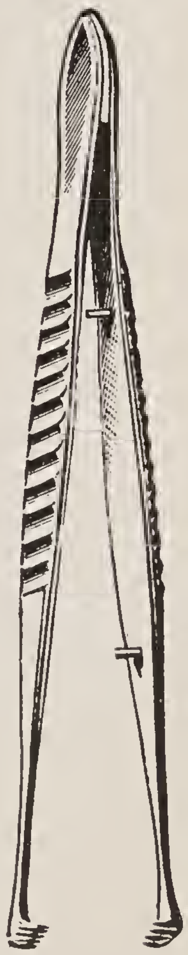

Fig. 58. Pile Forceps.

This is the operation I am in the habit of performing; but it may be somewhat modified. For instance, when the lateral pile is enlarged by the coalescence of piles on one or both sides of it, its base may be so broad that a single ligature would not sufficiently constrict it. In such a case, I bisect the hæmorrhoid, and continue the operation as though it were two piles. Again, where external tags accompany internal piles, instead of inserting the scissors in the sulcus between the two, thus separating the tag from the internal hæmorrhoid, the scissors are applied on the flat to the skin outside the tag, at a right angle to the long axis of the bowel, thus separating the tag as far as the sulcus; the handles are ~~now moved through~~ a quarter circle, and the rest of the cut is made parallel to the long axis of the bowel. Thus the tag and the pile are included in the same ligature, and the incision will be curved or rectangular, often laying bare the external sphincter on its inferior and internal surfaces.

The points to bear in mind are: Always operate on all the hæmorrhoids, otherwise a cure will not be effected, and the operation will be discredited. In applying the ligatures, tie them as tightly as possible and knot them off securely. Never cut off the piles: at the most remove only their apices, to make sure that the constriction is absolute. Concealed hæmorrhage has often followed the practice of cutting off the piles, owing to slipping of the ligature. Always see that all bleeding has ceased before completing the operation. Do not neglect to pass the finger, both at the operation and two or three times during the three or four subsequent weeks. Neglect of this precaution may lead to a subsequent operation for traumatic stricture.

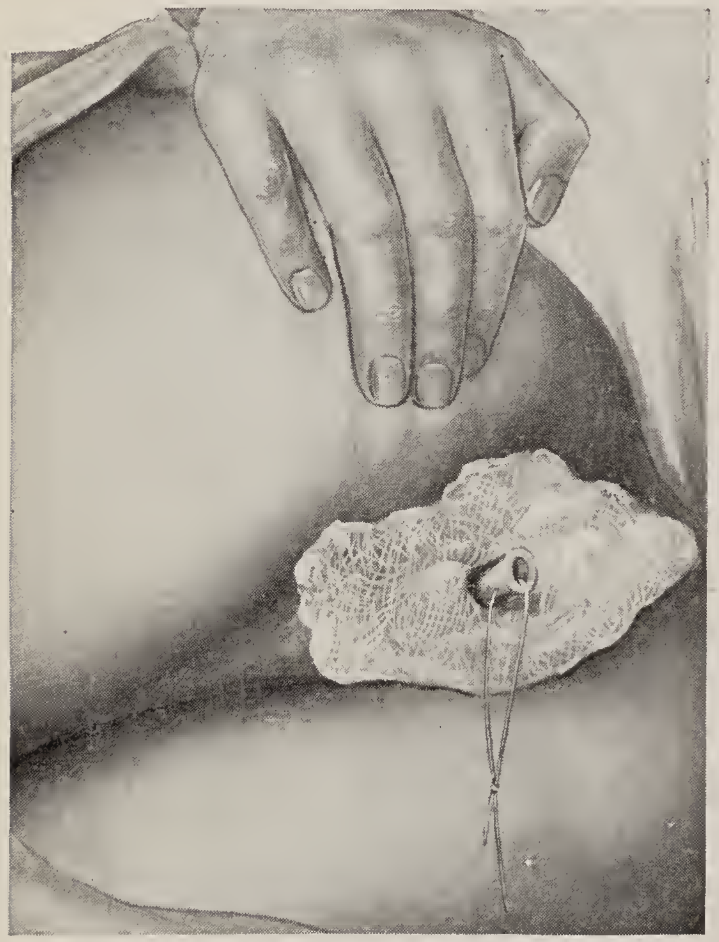

Fig. 59. Ligature Operation for Hæmorrhoids. *Sixth stage.* Rubber drainage tube surrounded by gauze or cotton-wool packing inserted after the operation for hæmorrhoids.

After-treatment. The patient must be kept quiet in bed, at least till after the ligatures and sloughs have separated, which usually occurs from the eighth to the tenth day, and low diet should be prescribed until the bowels have been moved. During the day of operation one or two hypodermic injections of morphine will be required. The bowels should be kept confined for four or five days. If they have been previously well cleared out many patients will not require any medicine for this purpose, the morphine given for the relief of pain being all that is required. If, owing to the patient's habit, anything further is thought to be necessary, a few doses of extr. opii, gr. ½ in a pill morning and evening, will suffice. Salol, grs. x twice daily while the bowels are confined, is very useful to prevent flatulence. On the morning of the fourth day a dose of castor oil should be given, and shortly afterwards 4 ounces of warm olive oil should be injected through the tube in the bowel, after which the tube is removed. If the patient objects to castor oil, some other suitable aperient may be given on the evening of the fourth day and the olive-oil enema administered early the following morning. Patients may use the commode, except the old and weak, who should use the bed-pan for the first two or three actions. After the bowels have been moved, the parts should be irrigated with a 1–2,000 solution of perchloride of mercury or some other suitable antiseptic, and dressings similar to those used at the operation should be applied. They should be reapplied twice daily.

As soon as the sloughs and ligatures have been cast off, the patient may leave the bed to recline on a sofa and walk about the room, and after a fortnight may walk in the open air. Sitting should be avoided as much as possible till the wounds are healed, which will generally be about the end of the third week. Soft seats should be avoided and wooden or cane-bottomed chairs should be used. The surgeon should gently introduce a finger well lubricated with vaseline into the bowel as soon as the ligatures have come away, to see if there is any contraction, and should repeat this as may be necessary. If after a fortnight the bowel be still found to be unduly constricted, the daily passage of a bougie, or dilatation with a bivalve speculum, should be carried out; with these precautions a stricture should never occur.

This operation is often followed by the formation of œdematous tags, even when all tags present at the time of the operation were excised; they generally disappear at the end of a few weeks after the application of strong lead lotion on swabs. A drachm of liq. plumbi subacet. fort. to the ounce of distilled water is a suitable strength.

Post-operation complications. *Retention of urine.* This occurs almost equally in both sexes. One should not be in too great a hurry to pass a catheter. Many patients can retain their water for twenty-four hours, at the end of which time, or before, success may crown their efforts. Warm fomentations over the bladder and genital organs should first be tried, and if these fail a male patient may make the endeavour standing up, or a female seated on a commode. If a catheter has to be used, the strictest antiseptic precautions should be observed. The catheter should be boiled, the hands and meatus cleansed, and sterilized glycerine used as a lubricant.

Hæmorrhage. Recurrent hæmorrhage occurs a few hours after the operation, from some vessel or vessels at the outer surface of the incision, which escaped notice at the operation, or from a slipped ligature. Secondary hæmorrhage occurs when the sloughs separate. Both forms of hæmorrhage require active treatment, as the effects may speedily become serious. The bleeding is usually internal, and a considerable quantity of blood may be lost before the condition is suspected, unless a tube be present in the bowel, which would give warning of the condition. If the bleeding be all outside, a little extra pressure of pad and bandage may suffice to check it, but if a vessel be pumping, it should be secured with a ligature, possibly without but preferably with general anæsthesia. If there be symptoms of great loss of blood, such as quick, feeble, and perhaps intermittent pulse, great pallor, sighing respiration, coldness of the extremities, clammy sweat, restlessness, or hiccough, the surgeon should introduce a finger of either hand into the bowel and open the anus; little resistance will be experienced if the hæmorrhage has come on soon after the operation, as the sphincter will not have recovered after its forcible stretching. The opening of the orifice will be followed by the expulsion of a quantity of dark blood-clot. The pile ligatures should now be pulled outwards and downwards to get a good view of the operation area, and any bleeding points seized with forceps and ligatured. The bowel should be well irrigated to get rid of as much as possible of the clot. No special bleeding vessels may be seen, but there may be a general oozing. In this case a vulcanite rectal tube, from 4 to 5 inches in length and at least ⅞ inch in diameter, should be inserted, and the bowel washed out with a warm sublimate solution (about 1 in 4,000) by means of a Higginson's syringe or a douche, to remove any high-lying clot; pressure by the hand above on the abdomen will help to clear out the clot and ensure that none of the solution is retained in the bowel. The tube, having a flange, will not slip into the bowel and is retained in position by a pad of cotton-wool and a T-bandage. If it would not entail too much delay, the patient should be given an anæsthetic, which prevents pain and enables the surgeon to do deliberately whatever is necessary without regard to the patient's feelings.

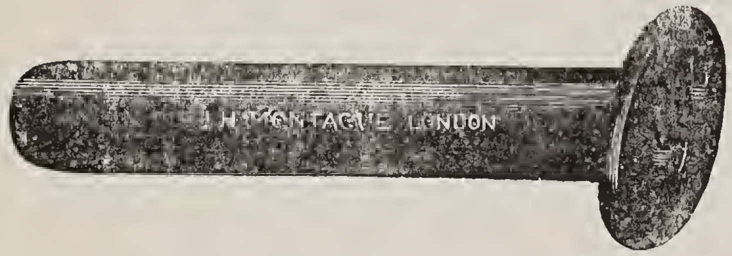

FIG. 60. VULCANITE RECTAL TUBE.

The tube should be left in at least twenty-four hours, both to control bleeding and to allow of the escape of old blood-clot. If the tube alone be insufficient to control the bleeding, strips of gauze or absorbent cotton-wool may be packed around it. In certain cases its use may be necessary for even three days, opium and catechu being given to prevent any action of the bowels. The tube is carefully removed by rotating it, leaving any packing, when any has been used, *in situ*. It is best not to promote an action of the bowels till several days afterwards; when this takes place the motions must be rendered quite soft by aperients and an olive-oil enema, and the patient must be warned against straining for fear of starting the hæmorrhage again.

Should hæmorrhage which requires treatment take place, say, seven or ten days after operation, it may be extremely difficult or impossible to religature the bleeding point. The 'petticoated tube' may then be used. A suitably strong tube about 6 inches long and ½ to ¾ inch in diameter, is passed so that one end projects about 1½ inches through the centre of a strong piece of sterile linen. The margin of the hole in the linen is then firmly fixed to the tube by tying a piece of silk tightly around, so that the apparatus is somewhat like a closed umbrella in shape. This end of the tube is now introduced up the bowel for about 3 inches and strips of gauze or other suitable material, which must be sterile and may be wrung out in some styptic solution, are packed in between the tube and linen, till a sufficient plug is obtained to control the hæmorrhage. A sponge of suitable size and shape with a hole through it is now slipped over the tube, and opposite sides of the linen are tied firmly over the sponge; the linen may be cut in strips to facilitate this. The tube is thus prevented from slipping up the bowel and any required degree of pressure can be applied. The presence of the tube allows flatus to pass and greatly adds to the comfort of the patient. Another method is to pass a dome-shaped Turkey sponge up the bowel, after

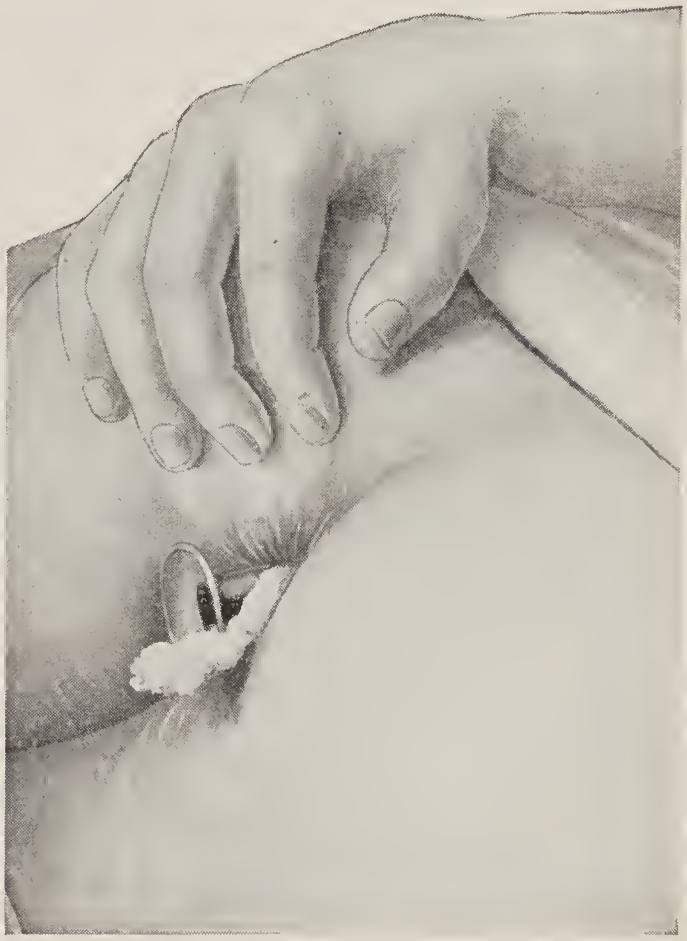

Fig. 61. Vulcanite Rectal Tube in situ. The tube has been inserted and packed around with gauze to control hæmorrhage.

wringing it out in an antiseptic solution and securing it by a strong ligature with two long ends passed through its apex; strips of gauze or pieces of cotton-wool well covered with powdered alum or other suitable styptic are packed in till the bowel is filled. Another sponge is placed outside the anus and between the ligatures, which are then pulled taut and securely fastened round it. In this method also, it is better to introduce a tube of some sort through the plug to allow the escape of flatus; a large gum-elastic catheter will be better than nothing. The plug should be left in as long as possible and morphine given to keep the patient comfortable. Although the treatment of hæmorrhage has been given somewhat fully, it rarely follows the ligature operation provided the piles are not cut off, or only a small portion of them, at the operation.

Other troubles are *ulceration, abscess, fistula, bubo,* and other results of septic absorption, all of which with proper antiseptic treatment should be avoided. *Contraction* of the mucous membrane about 1½ inches up the bowel is avoided by care at the operation, and the passage of the finger afterwards. If it be present it will yield to dilatation with the finger or bougies, aided if necessary by nicking of the constriction.

Results. After an experience of over a quarter of a century and the performance of thousands of operations for piles, I am firmly of opinion that Salmon's operation, as modified above, is the best all round operation. Recurrence after this operation when properly performed is practically unknown and risk to life must be infinitesimal, for I have never had a fatal case. I have never known it to be followed by incontinence or by stricture, where the after-treatment has been carried out as advised.

Removal by clamp and cautery. Indications. In the absence of external hæmorrhoids this is an excellent method for removing one or at the most three internal piles. Where more are present, the necessary manipulations to clamp them are apt to break open the eschars already made and to cause bleeding, for which a ligature, or possibly several, may be needed. Several deaths from hæmorrhage are known to have occurred after this operation, and if I lived at a distance from a patient on whom I had just operated, I should feel much happier if I knew his piles were in the grip of a strong ligature than I should be had I to trust to an eschar, which might be burst open by an unlooked-for escape of flatus or motion.

Operation. In this operation each hæmorrhoid is drawn down by means of forceps and a clamp is applied to its base in the long axis of the bowel. Henry Smith's or Gowlland's clamp may be used; the latter is the less cumbersome and also has another advantage—that, on being loosened, the last portion of the seared stump to escape is the upper part, where the main vessels are situated. After the clamp has been screwed up tightly the pile is cut off with a pair of curved scissors, leaving a good stump, to which the flat surface of a Paquelin's cautery at a dull red heat is thoroughly applied. The clamp is then slightly opened to see if any blood escapes, in which case the clamp is again tightened and the cautery applied. Its hold is again relaxed, and if there be no appearance of hæmorrhage, the instrument is carefully removed.

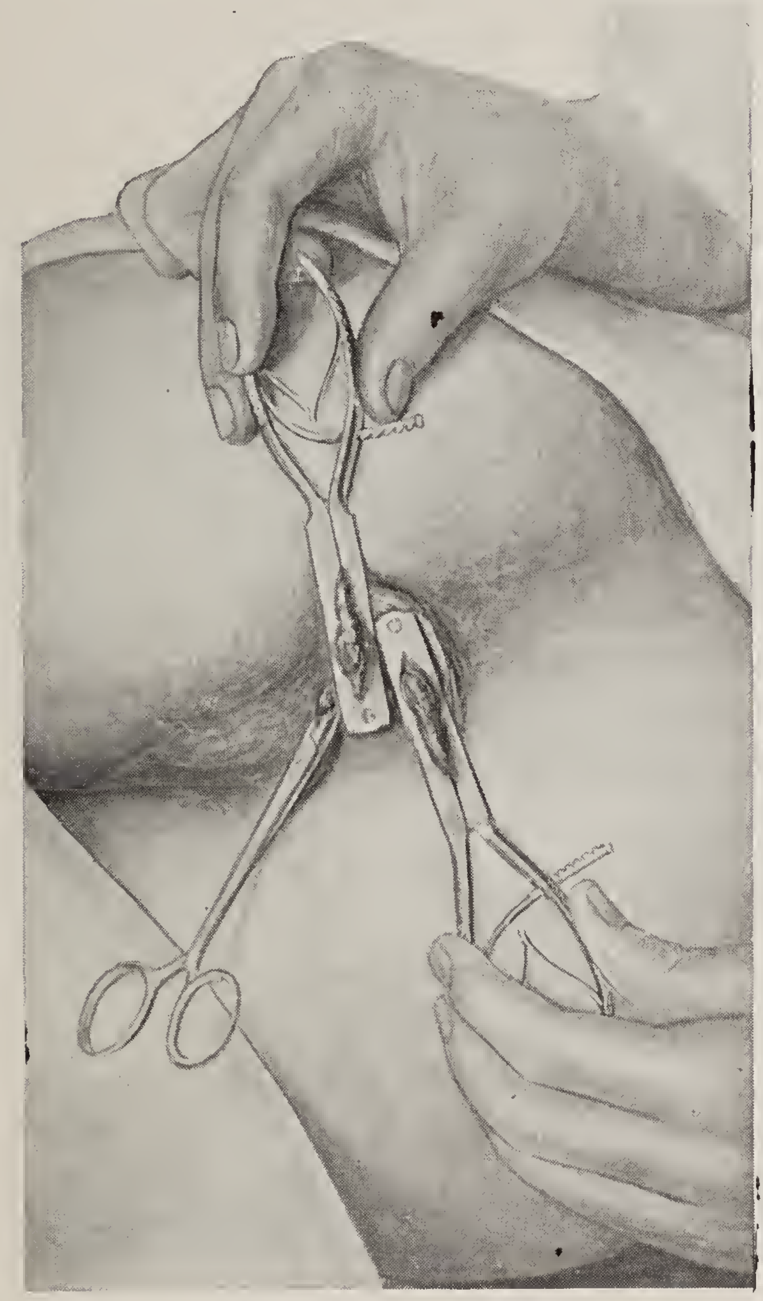

Fig. 62. Removal of Hæmorrhoids by the Clamp and Cautery. *First stage.* Two piles have been drawn down and a Gowlland's clamp applied to the base of each, in the long axis of the bowel.

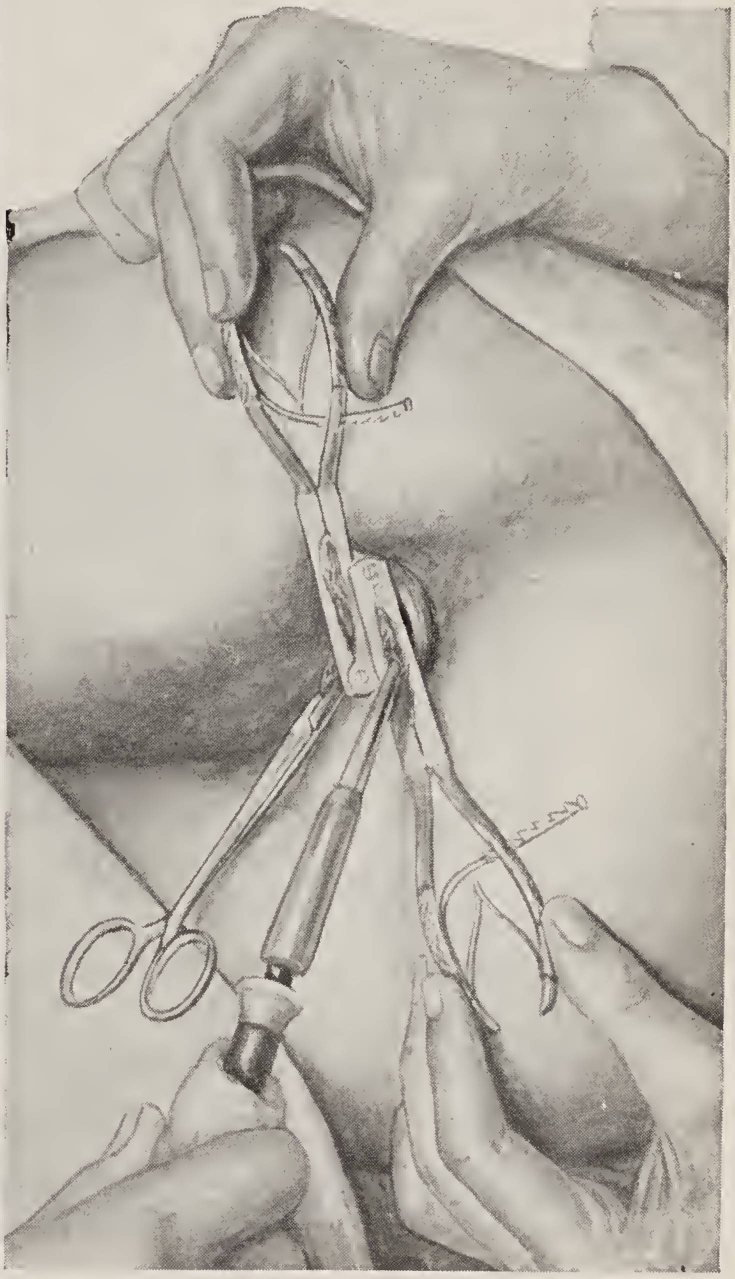

Fig. 63. Removal of Hæmorrhoids by the Clamp and Cautery. *Second stage.* Part of the piles have been cut off with curved scissors, leaving a good stump, which is being well seared with Paquelin's cautery at a dull red heat.

A rubber tube well smeared with vaseline is now inserted, as in the ligature operation. But here it is even more important, as by allowing the escape of flatus all distension of the anal canal is avoided, thus preventing hæmorrhage due to rupture of the eschars.

Results. Cure is more speedy than after the ligature (Salmon's) operation and usually there is less pain.

The smell caused by the burning is very objectionable, and special apparatus is required, and in the case of the benzoline cautery it is not always in order when it is wanted. When two or three piles are treated in this way, it is well to have as many small Gowlland's clamps as there are piles, so that there is no need to remove any one clamp until all piles have been treated; by this means any disturbance of the various eschars is avoided. It will now be evident why I have stated above that I consider this method should be limited to cases where not more than three internal piles have to be treated, for it will be found that there is no room for more than the application of three clamps at the same time.

The disadvantage of this method where external piles exist is that it is not suitable for their removal owing to the pain caused by a burn of the skin in this region. They will require excision with the probable application of several ligatures to bleeding points. Therefore, if ligatures have to be used at all, I think the whole operation is best carried out by that method.

REMOVAL BY CRUSHING

Allingham's crusher is made of solid steel, and has at one end an opening, up and down which a bar of steel is moved by a screw.

Indications. For one or at most two piles this method is as good as that with the clamp and cautery. It is also suitable for anæmic and debilitated persons, as very little blood is lost. When the piles are more numerous the same objections hold good as in the previous operation.

Operation. The pile is drawn through the opening of the crusher and the bar screwed tightly home, the base of the pile being compressed in the long axis of the bowel. The pile is then cut off with scissors beyond the clamp, which is left on for about three minutes. Contraction is somewhat likely to occur unless great care be taken not to remove too much tissue with the hæmorrhoids, and where more than two piles are being treated, there is danger of a partial reopening of the crushed stumps of those already operated upon, and of causing hæmorrhage.

Results. Probably somewhat less pain follows it, and healing is even more rapid than after removal by the clamp and cautery.

REMOVAL BY EXCISION

Excision with suture (*Earle's operation*). **Indications.** Uncomplicated internal piles of moderate severity. In severe cases there will be too much risk of contraction of the anal canal. This operation has its advocates, especially abroad; but I have found that the continuous suture is not always sufficient to control the hæmorrhage, thus necessitating a reopening of the wound in order to secure the bleeding points, which of course considerably lengthens the time necessary to carry out this method. Again, the risk of suppuration or stitch abscess is by no means chimerical.

Operation. After forcible dilatation of the anus, the pile is seized in a long thin clamp in the long axis of the bowel. A curved needle, armed with a long catgut suture, is passed through the fold of mucous membrane just above the forceps and tied; this should include the main vessels running into the pile, which is then cut off beyond the clamp. The needle and suture are now carried over the clamp, and through the two thicknesses of mucous membrane below it, thereby sewing up the clamp with the included stump by means of a continuous suture. The clamp is now removed, the suture pulled tight and tied towards the anal margin. Before cutting off the suture it is well to see that hæmorrhage is properly controlled, as sometimes a small vessel requires ligature. The wound should heal by first intention.

After-treatment. This is the same as for Salmon's operation (see p. 120).

Robert Jones's operation. The indications for this method are similar to those for Earle's operation.

Operation. After forcible dilatation of the anus, the lowest pile is seized with pressure forceps and drawn forwards, and its pedicle is placed within a long thin clamp, similar in shape to pressure forceps, in the long axis of the bowel. The bulk of the pile is now cut away with scissors, leaving a pedicle about an eighth of an inch deep, projecting from between the blades of the forceps. A piece of No. 2 catgut about one foot in length and armed with a straight needle at each end is now taken. One needle is now passed transversely through the pedicle of the pile just beyond the tip of the forceps so as to include the vessels. The catgut is drawn half-way through and then tied with a reef-knot, so that now there are two equal lengths of catgut with a needle at each end. One needle is then passed slightly obliquely through the upper end of the stump where it projects from between the forceps; the other needle is passed at the same level, also slightly obliquely, but in the opposite direction; the two sutures are then drawn tightly and a reef-knot is tied. This is repeated till the whole of the stump is closely sutured, there being about six of these cross sutures and knots to the inch. The clamp is slackened and occasionally a small vessel at the upper end of the stump may require ligature. Each pile is thus treated in turn, the parts washed over with an antiseptic solution, and a pad placed outside the anus.

After-treatment. The same as after Salmon's operation.

Results. The results of those by whom this operation has been employed are said to be excellent. No pain is complained of and convalescence ensues without hæmorrhage or suppuration.

Whitehead's method. (Excision of the pile-bearing area.)

Indications. Anæmic and debilitated patients are not suitable for this operation. When skilfully performed it is a good operation for cases of extensive and confluent piles, especially when associated with prolapse of the mucous membrane, but out of a large experience I personally have never found it necessary.

Operation. The patient, under the complete influence of an anæsthetic, is placed on a high narrow table, in the lithotomy position; the sphincters are thoroughly dilated, so that the hæmorrhoids can easily descend. By the use of scissors and dissecting-forceps the mucous membrane is divided at its junction with the skin round the entire circumference of the bowel, every irregularity of the skin being carefully followed. The external and the commencement of the internal sphincter are then exposed by a rapid dissection with blunt-pointed scissors and all bleeding vessels are immediately clamped. The whole pile-bearing area of mucous membrane, thus separated from the submucous bed on which it rested, is pulled bodily down, any undivided points of resistance being snipped across, until the hæmorrhoids are brought below the margin of the skin.

The mucous membrane above the hæmorrhoids is now divided transversely in successive stages, each vessel being clamped as it is divided. Four equidistant silkworm-gut sutures are now inserted through the skin, inner fibres of the external sphincter, and mucous membrane. The suturing is completed by the insertion of a continuous suture of iodized catgut, passing round the whole circumference, either one or two sutures being used for this purpose.

The separation of the mucous membrane from the skin should be commenced at the lowest point, and the two sides should be dealt with in succession, before completing the circle above. The incisions should be made through the mucous membrane and not through the skin. Carbolized silk is used by Mr. Whitehead for the sutures, which come away of themselves. The introduction of a suppository containing two grains of extract of belladonna, and the application to the parts of powdered iodoform or aristol, a pad of sterilized gauze, and a T-bandage, constitute the after-dressing.

After-treatment. For the first few days, with highly neurotic patients, the author of this method advises a bag of ice to be kept in close proximity to the rectum. An aperient is given on the morning of the fourth day, and the patient can resume work within a fortnight.

Whitehead contends that this method of operating is in perfect harmony with the best principles of surgery; that it can be performed with instruments always at hand; that it is a radical cure, safe as regards consequences; that the subsequent pain is comparatively slight, the loss of blood during the operation is very small, and the risks of secondary hæmorrhage less than those attendant upon the use of the clamp or ligature.

Comments. The objections to Whitehead's operation are somewhat numerous. In the first place, it is not easy of performance, and the time required varies from twenty to thirty minutes, and in the hands of those who have no special experience of this operation it may take even longer. Secondly, the bleeding is usually much more free than in the other methods of operating. Another objection consists in the fact that there is considerable risk of stricture of the rectum, inasmuch as the entire circumference is removed; and, when contraction does ensue, being situated at the junction of skin and mucous membrane, it is often difficult to overcome by dilatation, and may necessitate an internal proctotomy, with subsequent use of bougies for an indefinite period. The stricture follows the healing of a ring of granulation-tissue left when the sutures give way, which they more often do than not, at least in a part of the circumference. A stitch abscess, also, is by no means unknown. Another serious objection to Whitehead's operation is the loss of rectal sense, for a longer or shorter period, which occasionally ensues; and consequently the inability to appreciate the usual call to stool. Again, the difficulty in retaining flatus of which some patients complain is sufficiently distressing to make them regret that they had undergone the operation.

Mr. Anderson, House Surgeon at St. Mark's Hospital, has investigated the records of the last hundred cases of this operation performed in that institution, and informs me that complete primary union did not take place in a single case, no matter what suture material was employed. Some of the stitches cut out about the fourth day, and in many cases the whole of them, thereby leaving a large raw surface to granulate. The stay of each patient in hospital was usually between a month and six weeks, and eight had to undergo subsequent treatment for stricture.

Choice of operation. From what has been said it will be obvious that I do not recommend Whitehead's operation for piles, although it is useful in cases of prolapsus ani. In cases of any magnitude and those associated with fissure and fistula, I prefer Salmon's operation, and for slighter cases the clamp and cautery. I regret that I have no experience of Jones's operation, but the method appears to be a good one and may possibly become the operation of the future in uncomplicated cases where the piles are not too numerous.

CHAPTER V

EXCISION OF THE RECTUM

Indications. This operation is seldom employed for any condition other than malignant disease of the anus or rectum. It has been done in some cases of multiple simple stricture of the rectum with extensive ulceration, when it was impossible to keep the bowel patent by means of bougies, but with very unfavourable results. Nor is it likely to be otherwise, because in these cases the perirectal tissues are much thickened by inflammatory infiltration and the bowel is bound down to surrounding parts, rendering its separation from neighbouring organs very difficult and dangerous. Moreover, in cases not amenable to other methods of treatment, it is not likely that the operator would be able to effect either a rectorrhaphy or the establishment of a normal anus; therefore in these cases colostomy and not excision should be performed.

The choice of the particular method of operation will depend upon the position and movability of the growth. A tumour situated in the anal canal should be removed by the *perineal route;* one situated between the third sacral vertebra and the upper border of the external sphincter, by the *sacro-coccygeal route;* a growth above this may require *excision by abdominal section,* or a combined *abdomino-sacral, abdomino-perineal,* or *abdomino-anal* operation. When the growth is adherent to the vagina the *vaginal route* may be employed.

Before deciding on the suitability of the case for operation, it must be ascertained if the bowel containing the growth be movable on the surrounding tissues; these are the most favourable cases. When any fixation is present the question of operation becomes much more difficult, as the growth has probably spread through the rectal wall and invaded the neighbouring parts, though it should be borne in mind that the impaired mobility may be due to inflammatory processes only. If the growth be fixed only posteriorly and there be no evidence that the nerves are involved, an operation by the posterior route may remove the extension of the disease at the same time as the primary growth. If the attachment has taken place anteriorly, complete removal becomes much more problematical, owing to the infiltration of other pelvic viscera, such as the bladder, prostate, uterus, and vagina. Although the whole or portions of some of these may be removed with the original growth, the chances of a cure become much more remote, except perhaps where there is a small infiltration of the vagina. In these cases the conditions should be explained to the patient and friends, and if there is a reasonable chance of success an operation may be done, if particularly desired by the patient. The operation for extirpation of a carcinoma of the rectum is a severe one, and should only be undertaken if the general condition of the patient be favourable. If there be no disease of any important organ, it may be that a patient whose general condition is unfavourable may be so improved by careful dieting and intestinal lavage as to make an operation justifiable. The question of enlarged lymph glands in the mesorectum is an important one, but where only a few movable ones are found operation is justified, provided the growth also be movable. The enlargement may be merely inflammatory. If metastatic deposits are detected they negative any attempt at extirpation.

Colostomy as a preliminary measure to extirpation of the growth. Opinions have differed much as to the advisability of this procedure. Where there is sufficient obstruction to the passage of the bowel contents to prevent a thorough clearance of the large intestine prior to operation, a colostomy for this purpose is most desirable. It should be done as high up as possible in the sigmoid colon, so as not to interfere with the drawing down of the bowel at the radical operation. In order to prevent this some advise that the colostomy opening should be placed in the middle of the transverse colon. This makes cleansing of the bowel above the growth more difficult, and the cases are few where the mobility of the bowel will be so impaired as to prevent a rectorrhaphy being performed after excision, though it is quite likely to prevent the proximal end of the bowel being brought down to the anal margin after an excision, but in these cases the colostomy opening could be closed and the bowel separated from the abdominal wall. Again, in cases where it is impossible to bring the bowel down to the anus and establish proper control, a preliminary or subsequent colostomy is advisable. In all other cases a colostomy is unnecessary and subjects a patient to two or even three operations where one should suffice. It should be mentioned that some tumours which at first appeared too fixed for removal have, two or three weeks after colostomy, become sufficiently movable for a successful extirpation to be carried out. In suitable cases, therefore, a further examination should be made to see if the hoped-for improvement has taken place.

Preparatory treatment. For at least a week previous to the excision mild aperients should be administered daily, and for four days before operation intestinal lavage should be carried out two or three times daily with a weak solution of a non-poisonous antiseptic, such as chinosol (1 in 600) or sanitas; it is also a good plan to give 10 grains of salol twice daily for the same time, to act as an intestinal disinfectant. Probably a much more effective method is to administer an active preparation of Bulgarian lactic acid bacilli, for at least a week before the operation. Care must be taken not to weaken the patient by over-purging, and he should be carefully and frequently fed with easily digested and nutritious food, leaving little residue; such as eggs, meat, breast of chicken and game, fish, tripe, liver, sweetbread, tapioca, sago, arrowroot, rice, macaroni, vermicelli, potatoes, maize, thin white toast, biscuits, pulled white bread, plasmon, protene, sugar, and butter.

EXCISION BY THE PERINEAL ROUTE (Quénu)

Indications. A malignant growth involving the anus, anal canal, and rectal ampulla, *i.e.* the dilated portion of the rectum immediately above the anal canal. Where the growth involves the anal skin, the inguinal glands are likely to be involved and will require excision at the same time or subsequently.

Operation. After being anæsthetized, the patient is placed in the lithotomy position with the pelvis slightly raised by means of a small cushion under the sacrum. The sphincter is stretched, if it is to be saved, and the rectum is well douched with a 1–4,000 solution of sublimate or biniodide of mercury or 1 in 600 chinosol, and dried. If it be possible to save the external sphincter, a circular incision is made around the anus at the muco-cutaneous junction, as in Whitehead's operation for hæmorrhoids; if the sphincter be involved in the disease, the circular incision must be made in the skin outside the anus. A circular cuff of mucous membrane is now dissected up and a stout silk ligature tied tightly round it, to prevent contamination from the interior of the rectum. The end of the stump is then disinfected by being rubbed over with liquefied carbolic acid or the actual cautery. The incision is now carried exactly in the mid-line forwards nearly to the scrotum and backwards to the tip of the coccyx, the external sphincter being divided behind and retracted with the skin. The median incision is deepened till the muscular coat of the bowel is exposed, as it will be after the fibres of the levator ani, which unite in the mid-line, have been cut through. The circular incision is then deepened, and the levator ani on each side is cut through, after it has been defined by passing the left index-finger under it from the median incision; this is done with blunt-pointed scissors close to the bowel. All bleeding vessels must be seized at once and ligatured when convenient. By blunt dissection and the aid of the scissors where necessary, the bowel is freed behind, at the sides, and in front. If the patient be a male, a metal sound in the urethra held well up under the pubes is of much service at this stage in defining this passage and so preventing injury to it; great care must also be taken not to injure the bladder or ureters. In the case of a female, an assistant's finger in the vagina is a useful guide.

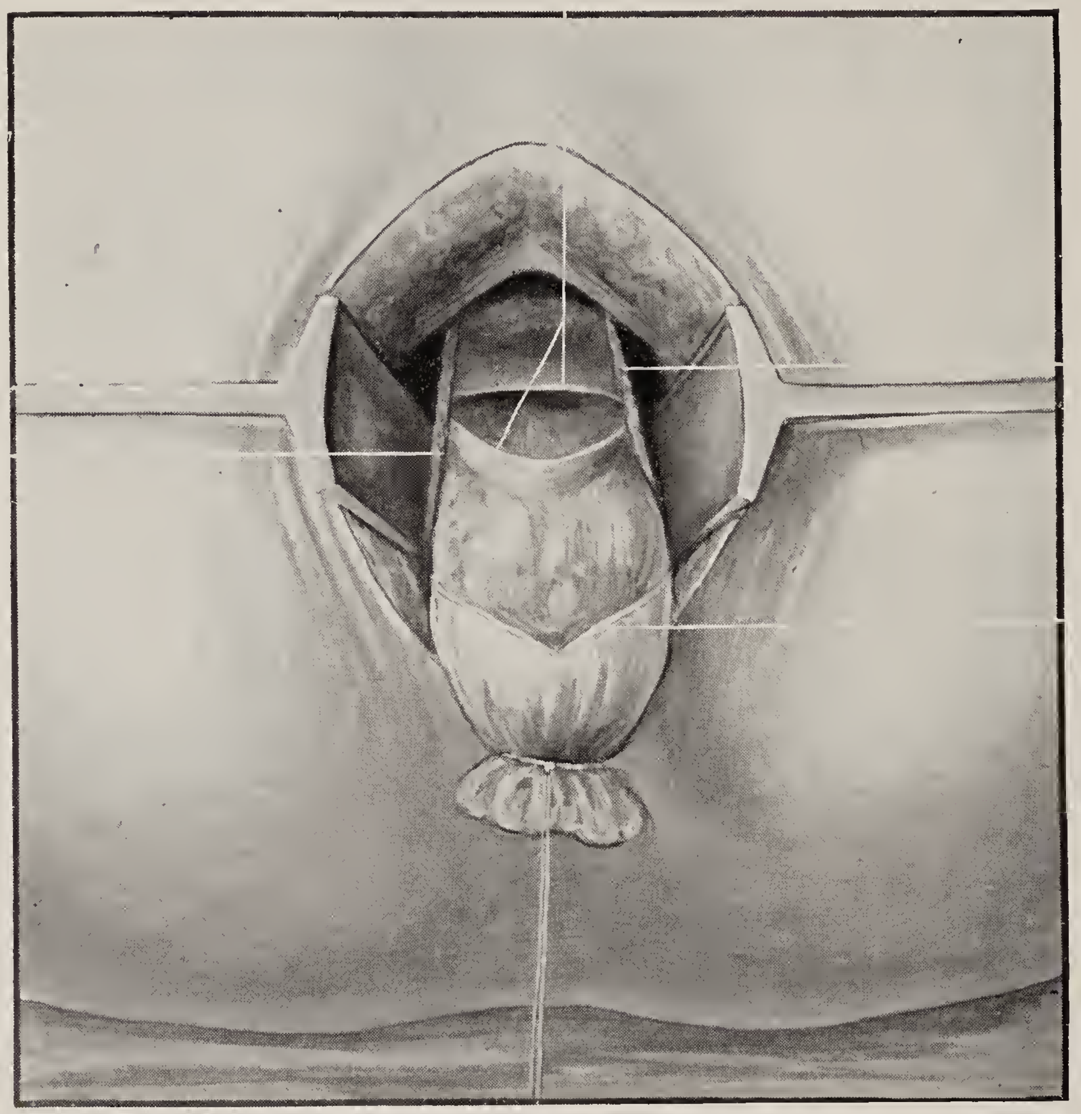

Fig. 64. Excision of the Rectum by the Perineal Method. The bowel is freed from the levator ani, A, A, A, and the peritoneum, B, has been opened. A ligature has been tied tightly round the lower end of the bowel.

After careful separation anteriorly to a depth of 2½ to 3 inches the peritoneal reflexion is displayed; it may be necessary to divide this in front and laterally to get well above the growth and draw healthy bowel down to the skin. The mesorectum should be divided close to the sacrum, to prevent injury to the middle hæmorrhoid artery and to remove the glands. In some cases it may be possible to peel the peritoneum off the rectum without opening it, but it may be then difficult to bring the cut end of the bowel down to the skin without tension. The parietal peritoneum is now sutured with a continuous fine silk stitch to the rectal wall and the opening in the peritoneum is closed, while an assistant is pulling the bowel downwards and backwards. This stitch also tends to prevent retraction of the bowel, which on the proximal side of the growth will now have been so much pulled down that it will be on a level with the anus. The rectum is clamped well above the line of section with suitable forceps, having their handles directed backwards out of the way, and is cut across at the level of the skin and a good inch above the growth. If no clamp be used, the vessels are caught and ligatured as they are divided. The end of the bowel is united to the skin by interrupted sutures of silkworm-gut, which pass through all the coats. The clamp is now removed and any bleeding point ligatured. If the sphincter has been preserved its divided extremities must be carefully united by buried sutures of chromic catgut and the skin sutured with silkworm-gut, allowing for efficient drainage before and behind. The cut edges of the levator ani are sewn to each other with chromic catgut sutures, both before and behind the bowel, and also to the wall of the latter. It is important to insert a large rubber tube into the bowel, which can be maintained in place by one or two silkworm-gut sutures. Antiseptic dressings are then applied in the usual way.

Difficulties and dangers. When the peritoneum is not opened there is often difficulty in loosening the upper rectum sufficiently to bring it to the skin. When the peritoneum is opened the chief difficulty is in separating the bowel and arresting hæmorrhage in the depths of the wound. Great gentleness must be employed in separating the tissues behind the bowel and care taken to keep close to the sacrum, so as not to injure its blood-supply, or sloughing will result. There is considerable risk of excessive loss of blood in this operation; this must be avoided by securing every bleeding vessel at once. Other dangers are injury to the bladder, urethra, seminal vesicles, and ureters; these are prevented by careful dissection and avoidance of tearing.

After-treatment. Means must be taken to combat shock, if present, and morphine administered hypodermically to relieve pain. The wound must be kept clean and sweet by irrigations two or three times daily with antiseptic solutions, after which the parts are dried and dusted with an antiseptic powder, such as aristol, and dressing reapplied. The patient should be frequently fed with small quantities of nutritious, easily digested food. In the absence of troublesome flatulence and discomfort the bowels should be moved about seven days after operation. An aperient should be given by the mouth and a warm olive-oil enema given before the bowels act. It is very important, if the sphincter has been preserved and sutured, to prevent the passage of hard scybala.

If the patient has difficulty in emptying the intestine, he must be directed not to strain down, and if a lubricated finger gently inserted confirms the presence of hard motions which have not been softened by the oil enema, it is a good plan to add a drachm of purified ox-gall to a pint of warm water and slowly inject this into the bowel. If the ox-gall has become hard it should be rubbed down in a small quantity of boiling water first. The ox-gall solution should be retained for half an hour or more to allow the motions to become softened; it should then be allowed to escape, and afterwards the bowel carefully washed out with a soap-and-water enema, or the oil should be again administered if the ox-gall has not been quite successful. Afterwards an aperient should be given every other day and the same precautions against straining adopted.

Complications. *Septic troubles,* which are to be avoided by careful emptying and cleansing of the bowel previous to operation and avoidance of infection of the wound. *Stricture,* owing to giving way of the sutures. This will be treated by dilatation with the finger and bougies, and is to be avoided by keeping the wound aseptic, by not tying the sutures too tightly, and the avoidance of tension. *Urinary fistula* is avoided by taking care not to injure the urinary tract. If present, a fistula may close spontaneously or it may require a plastic operation later on. *Gangrene of the stump* is prevented by avoiding injury to the superior hæmorrhoidal artery. To do this great gentleness must be exercised in separating the bowel high up behind and by keeping close to the sacrum. *Prolapse of the mucous membrane;* if this causes inconvenience, it should be removed by an operation similar to Whitehead's for piles.

Results. This operation is attended with a low mortality, but is usually followed by some incontinence if the bowels are at all relaxed, even when the external sphincter has been preserved. This is owing to injury either to the muscle itself or its innervation.

EXCISION BY THE SACRO-COCCYGEAL ROUTE (Kraske)

Since Kraske first introduced his method of removing the coccyx and a small piece of the left side of the sacrum, along a line commencing at the left side of the sacrum, at the level of the third posterior sacral foramen, curving inwards and downwards through the fourth left posterior foramen to the left lower corner of the sacrum, various modifications have been suggested, the main feature of each being the position in which the sacrum is divided. Thus Bardenheuer divides the whole of the bone below the third foramina, others have removed the bone

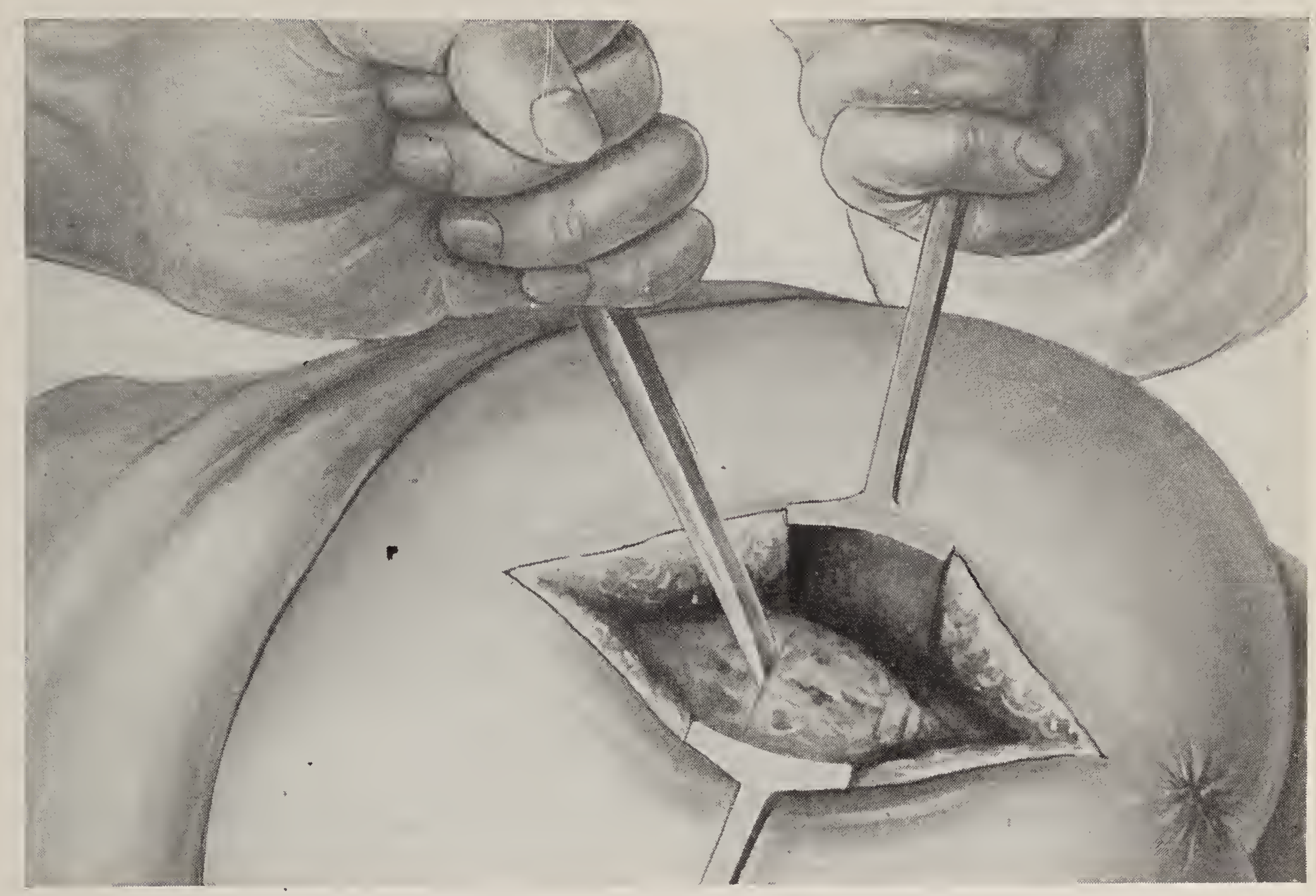

Fig. 65. Parasacral Excision of the Rectum. *First stage.* The coccyx and lower part of the sacrum having been exposed by means of a median longitudinal incision, the sacrum is being divided transversely with a chisel.

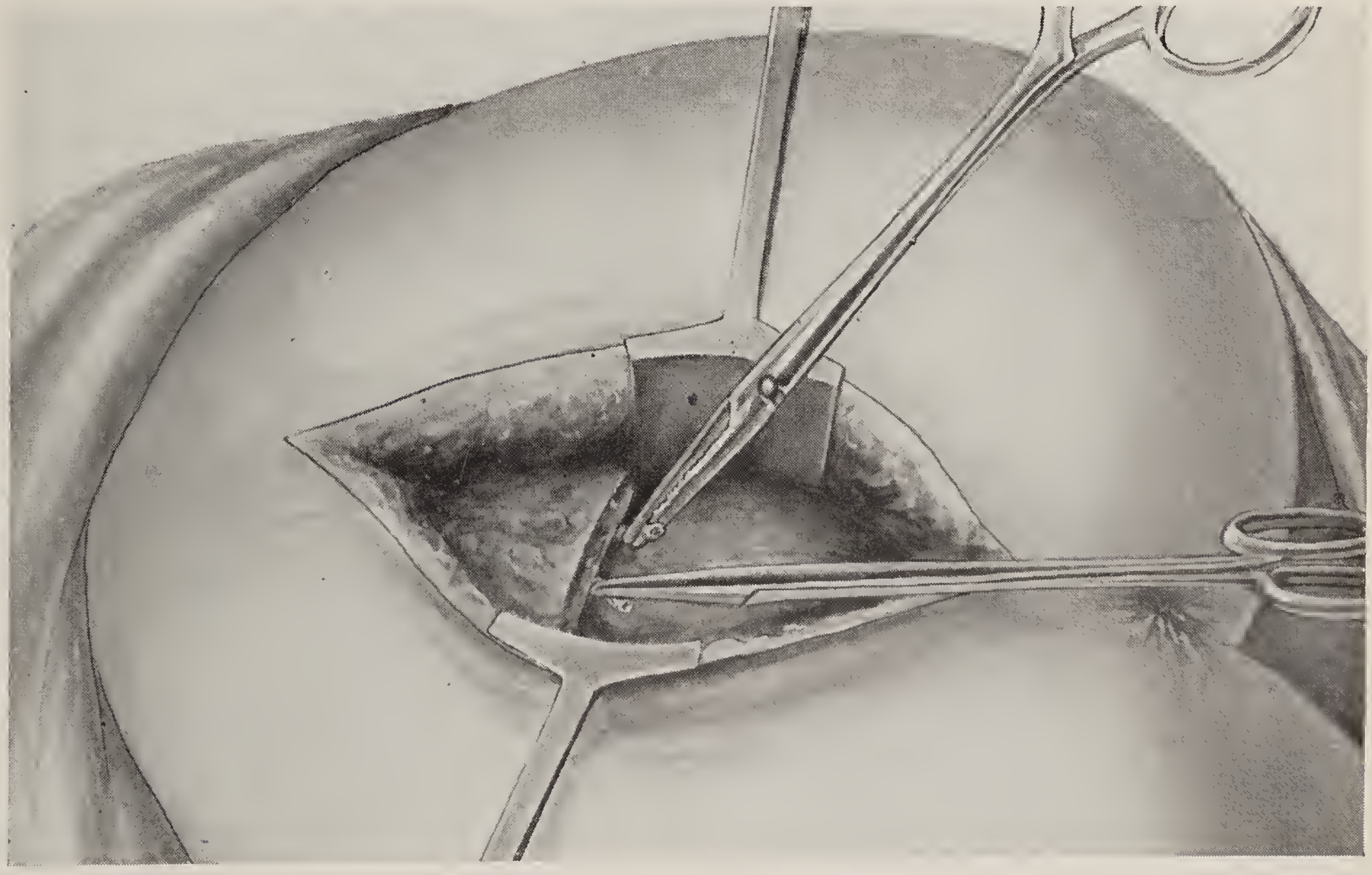

Fig. 66. Parasacral Excision of the Rectum. *Second stage.* The coccyx and part of the sacrum have been removed and the sacra media vessels caught in clip-forceps; under the forceps is the rectum surrounded by the perirectal tissues.

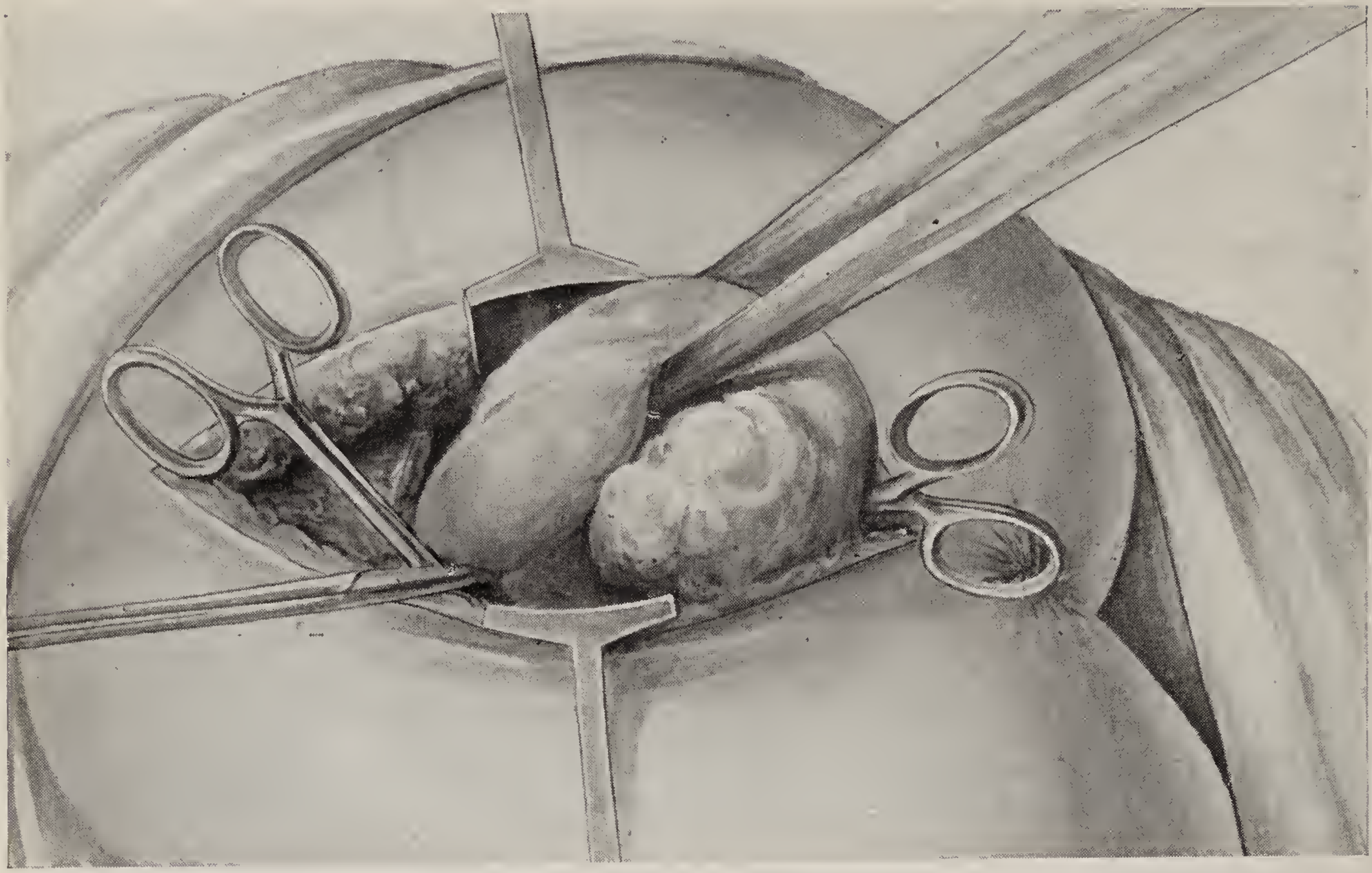

FIG. 67. PARASACRAL EXCISION OF THE RECTUM. *Third stage.* The rectum is being pulled out of the wound by a fold of gauze, after the peritoneal cavity has been opened on either side. Between the gauze and the lower angle of the wound is the portion of cancerous bowel about to be excised.

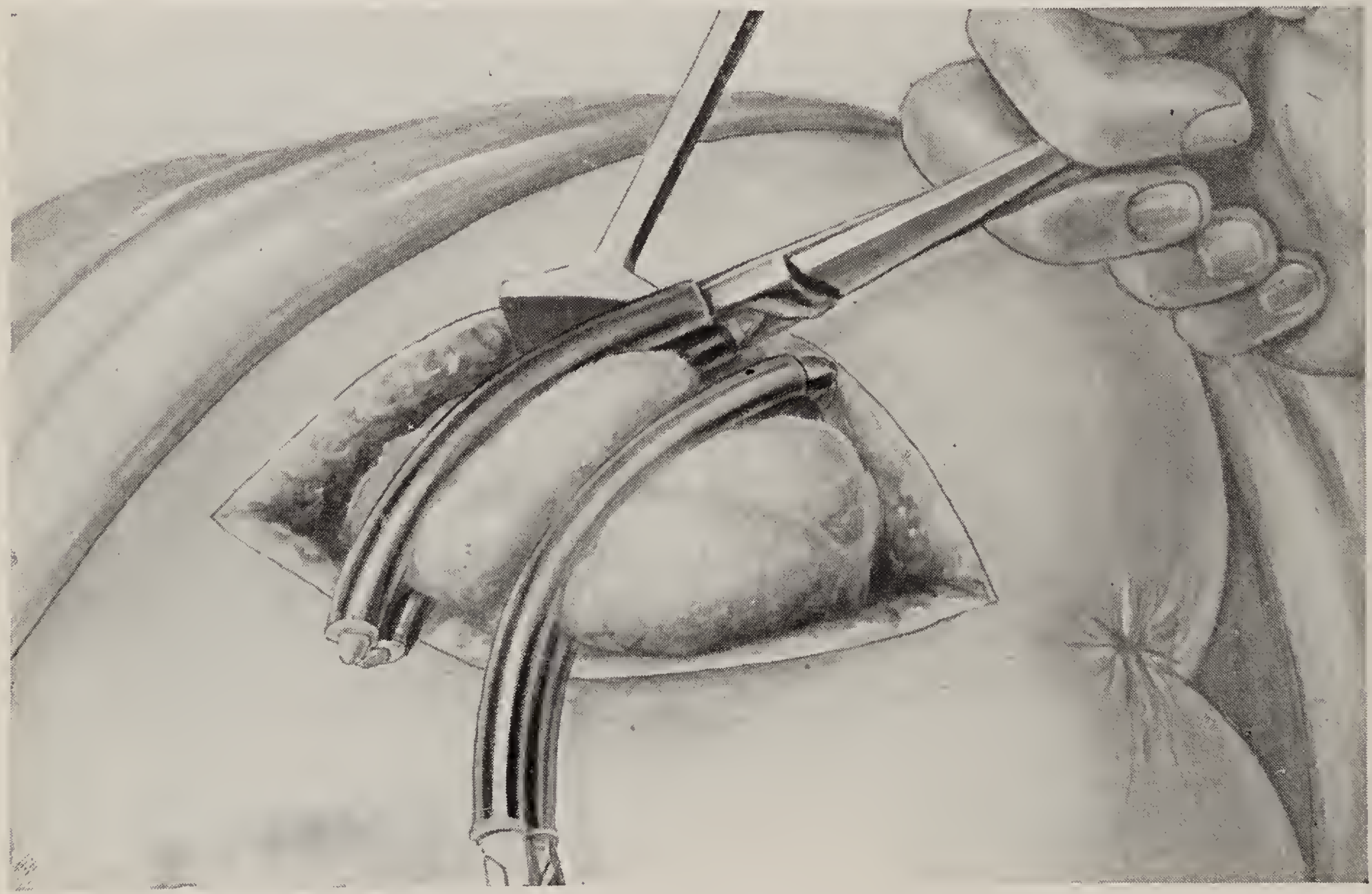

FIG. 68. PARASACRAL EXCISION OF THE RECTUM. *Fourth stage.* The bowel is held by two rubber-covered clamps at least an inch above the growth, and is about to be divided between them.

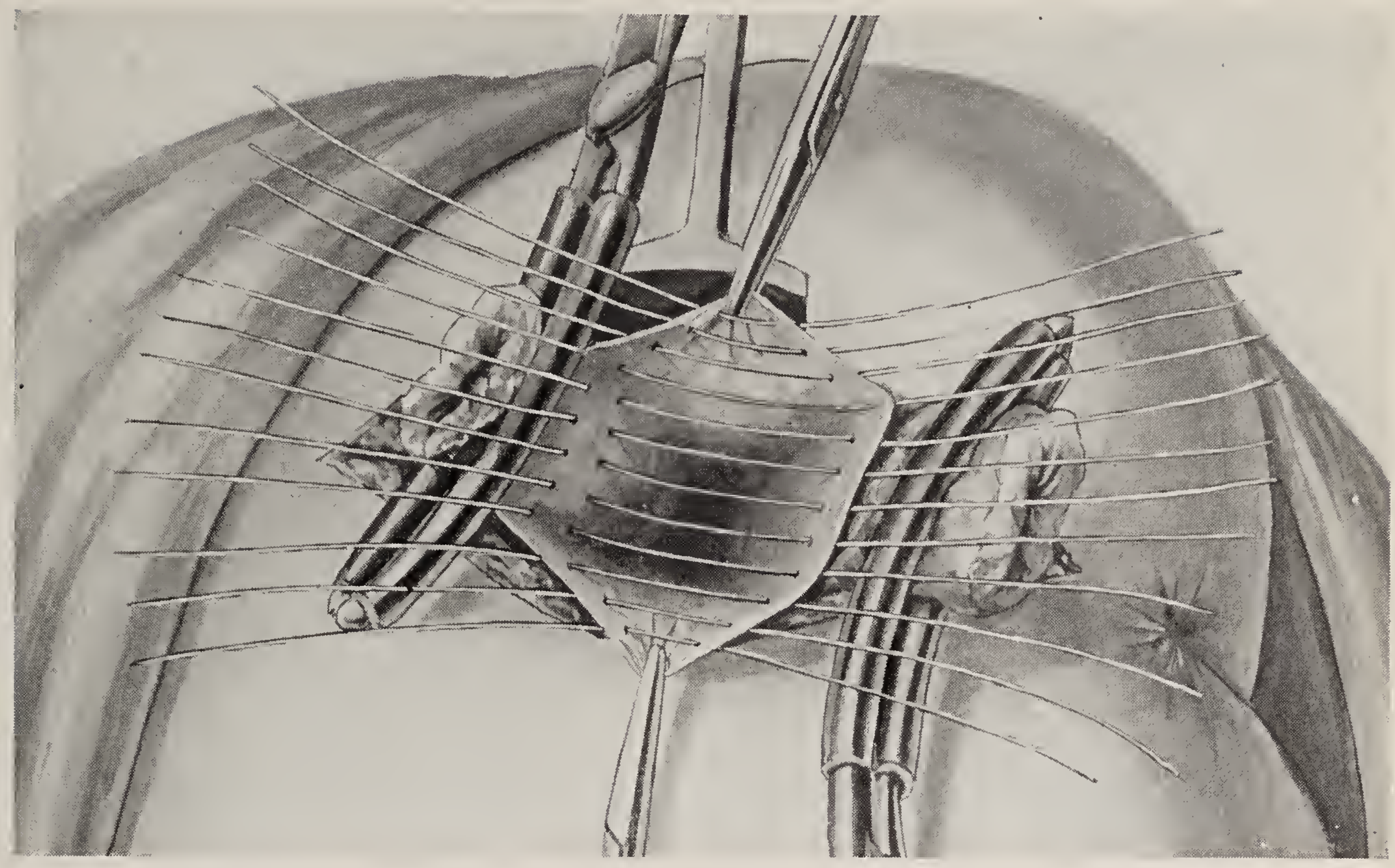

Fig. 69. Parasacral Excision of the Rectum. *Fifth stage.* The excision has been carried out, and the upper and lower ends of the bowel are shown clamped. Compression forceps are pulling apart the opened peritoneal cavity in order to fix it, thus facilitating the insertion of a series of interrupted silk sutures.

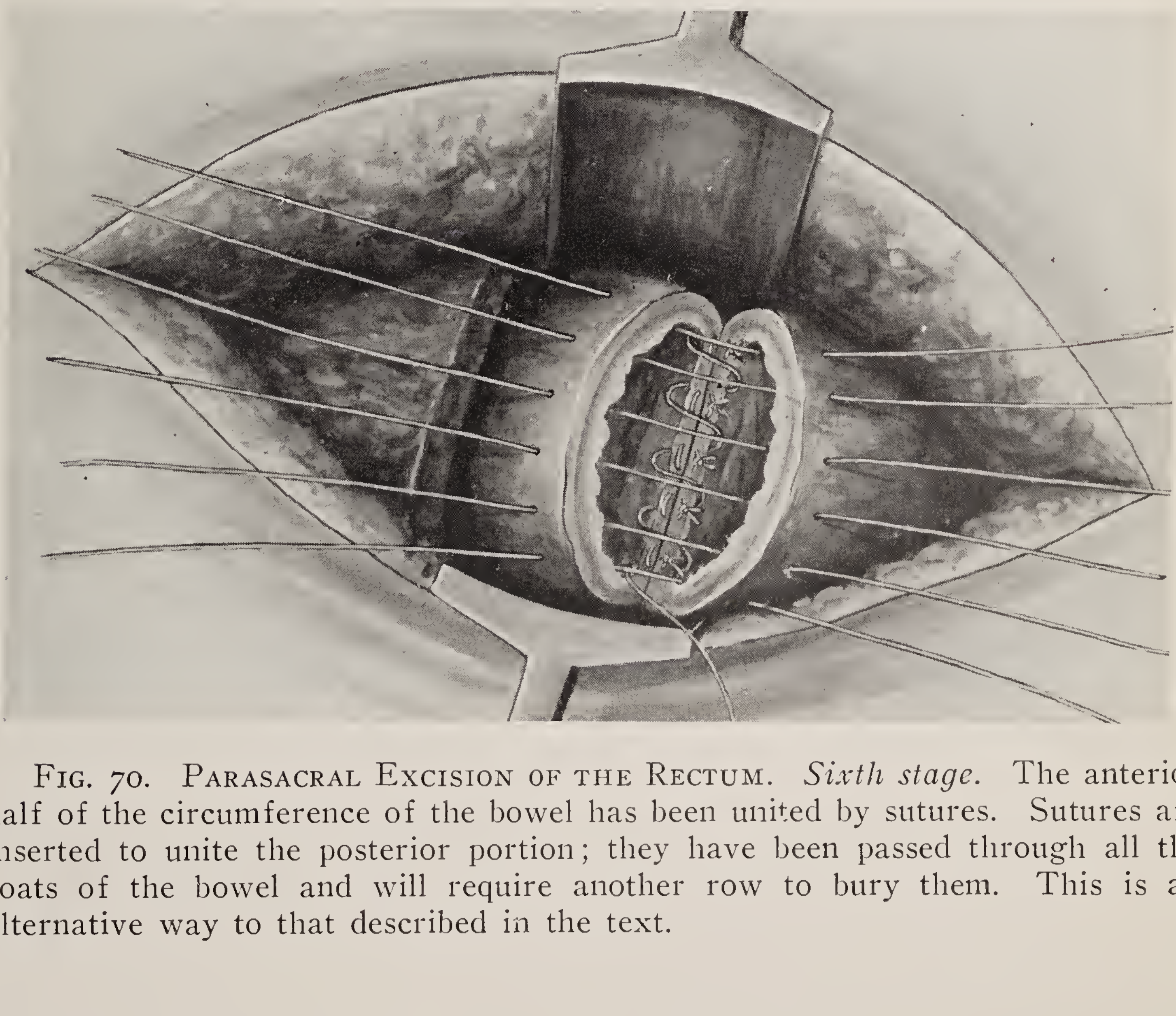

Fig. 70. Parasacral Excision of the Rectum. *Sixth stage.* The anterior half of the circumference of the bowel has been united by sutures. Sutures are inserted to unite the posterior portion; they have been passed through all the coats of the bowel and will require another row to bury them. This is an alternative way to that described in the text.

below the second foramina. Heinecke turned the lower end of the sacrum and coccyx outwards on a hinge formed by the sacro-sciatic ligaments and replaced them at the end of the excision; necrosis is, however, liable to take place in this operation, but this is not nearly so likely to occur if the bone is not wired, but is held *in situ* by catgut sutures passed through the soft structures only. Kraske now advises removal of the coccyx only, unless additional room be required, and this is the procedure which should be adopted.

Indications. For malignant growth which extends up as high as the middle of the sacrum.

Operation. The whole operation area having been prepared and an antiseptic compress applied the day previously and again on the morning of the operation, the patient is anæsthetized and placed in the left lateral position with the pelvis well elevated. The patient may be in Littlewood's kneeling position, with the pelvis well raised and the lower extremities supported on a chair, or on his right side, or in the lithotomy position with a sand-bag under the lumbar spine and the thighs well flexed; but I prefer the first. The anal sphincter is stretched and the rectum is washed out with 1 in 600 chinosol solution through a bivalve speculum. A median vertical incision is then made from the middle of the sacrum to just behind the anus, and deepened till the sacrum and coccyx are exposed. The amount of bone to be removed depends to a large extent upon the position of the growth as found at a previous examination, and in many cases the removal of the coccyx alone is all that is required. If this be not sufficient, the soft parts are peeled off from either side of the sacrum and coccyx, and the ligaments attached to either side divided. The bone is cleared on its anterior surface with a blunt dissector, the sacrum is cut through transversely with a chisel and mallet, and the part below the cut is removed. This is done at some point below the level of the third posterior sacral foramina, according to the room required. In this way it is usual to remove 1 or 2 inches of the sacrum or even more. If hæmorrhage takes place it is arrested, but difficulty may be experienced in securing the lateral and middle sacral vessels with forceps, as they may retract under the bone and be difficult to seize. Rather than waste time by many endeavours to ligature these vessels at this stage, bleeding may be controlled by firm pressure with a gauze tampon on the part of an assistant, whilst the operation is continued. For the more convenient ligature of these deeply-placed vessels I have devised a compression forceps combining the advantages of Greig-Smith's shape with that of Lawson Tait (see Fig. 71). The shape is that of Greig-Smith's with transverse serrations, for I found that Greig-Smith's forceps were apt to sever the vessel, thereby rendering a second application of the ligature necessary on a much shortened and retracted vessel.

The tissues in the mid-line behind the rectum are now incised in a vertical direction till the levator ani is reached, when the latter is divided on either side with scissors. With very little further separation of the perirectal tissues with the fingers, the bowel is exposed and the upper and lower limits of the growth are defined. It is well not to attempt to dissect out the bowel too freely from its bed of perirectal fat, by which much bleeding is avoided and the lymphatic paths from the growth remain undisturbed. Separation of the posterior and lateral walls having been chiefly effected with the aid of the finger, it remains to deal with the anterior. The position of the growth will now determine the next stage of the operation, the object being to remove the growth with at least an inch of healthy bowel above and below it and to reunite the cut ends of the upper and lower segments by circular suture; or to bring the lower end of the upper segment through the lumen of the lower segment and unite the former to the margin of the anus, after removing the mucous lining of the lower segment. It may be possible to draw the bowel down far enough without interfering with the peritoneum, or, after stripping it upwards off the front of the bowel, without opening it, but in the majority of cases the peritoneum must be opened. It is found at the upper part of the wound by blunt dissection and is opened close to the bowel for fear of injuring the ureters. Its anterior and lateral reflections are divided to a sufficient extent, and the mesentery of the rectum is divided close to the bone to avoid injury to the blood-supply of the bowel. At the same time the glands and connective tissue are separated from the hollow of the sacrum as far as may be necessary. When the bowel can be drawn down far enough, the peritoneum is closed with interrupted catgut sutures, and sutured to the bowel; this tends to prevent retraction. The bowel is then divided an inch or inch and a half above the growth between two clamps or two pieces of tape or thick silk tied tightly round it; at the back is seen the divided superior hæmorrhoidal artery, which is ligatured. The lower segment of the bowel is then freed in front from above downwards. It is much easier to do this from above downwards than from below upwards; there is also less hæmorrhage.

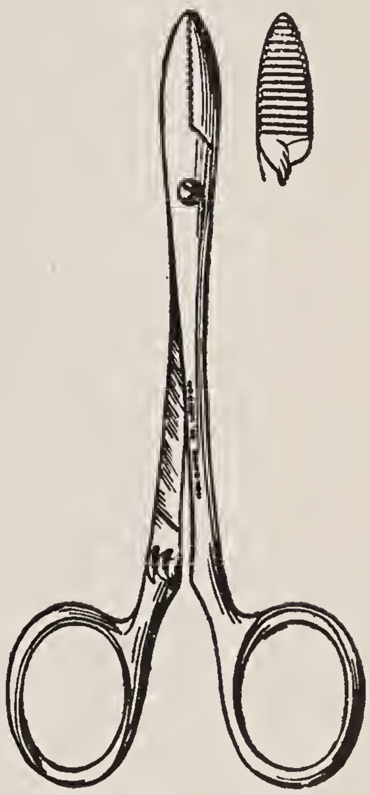

FIG. 71. COMPRESSION FORCEPS. (*Author's pattern.*)

An assistant's finger in the vagina, or a steel sound in the male urethra, will make the separation of the bowel from the organs in front safer. Care must be taken, by careful packing with gauze, that there is no contamination of the wound when the bowel is opened, but if the bowel has been properly prepared beforehand, and especially if a previous colostomy has been done, there is not much risk of this taking place. When the bowel has been freed for at least an inch below the growth, it is divided between two clamps. If now the upper segment can be brought down far enough, and there is sufficient bowel left above the sphincters in the lower portion to allow it, the cut ends are united by circular rectorrhaphy. This is done in two layers, using silk for the fibro-muscular layer, sewing the anterior half of the circumference first. The mucous coat is then united with No. 2 28-day chromicized catgut sutures, knotted on the inner surface. Finally, the posterior half of the fibro-muscular coat is sutured with fine silk. A few extra sutures are put in if any part of the junction appears to need additional support. The whole operation area is now well irrigated with warm 1 in 4,000 perchloride of mercury lotion. A large rubber tube, 6 inches long, ¾ inch in diameter, is inserted into the bowel, its upper end well above the suture line, and the posterior wound is closed, buried sutures of catgut being used when exudation might collect and decompose. Efficient drainage is provided for by one or more rubber tubes and strips of sterilized gauze. In order to prevent strain on the bowel sutures, the anus is first well stretched and the external sphincter divided subcutaneously.

In some cases the mucous lining of the anal canal is removed and the lower end of the upper segment is drawn through the sphincters and sutured to the skin; when this can be done without tension it is a very good method. When it is impossible to bring the upper bowel down to the anus or to do a circular rectorrhaphy, its lower end is sometimes sutured to the upper part of the cutaneous incision, forming a sacral anus. Before this is done the bowel should receive a half or three-quarter twist on its longitudinal axis, enough to hinder somewhat the introduction of the finger into the bowel; this to some extent improves the patient's power of control of the bowel contents in some cases. The existence of a sacral anus, however, is a trouble and annoyance to the patient; he has little or no control over the fæcal evacuation, which is projected backwards instead of downwards. The opening is in such a position that it is difficult for him to attend to the cleansing of it, and a subsequent prolapse of the bowel is likely to cause great annoyance. A sacral anus, therefore, compares very unfavourably with that of an iliac colostomy, for here the opening can be looked after by the patient himself, whilst a considerable amount of control is afforded by the surrounding abdominal muscles, when the operation has been efficiently performed. It may, therefore, be necessary, when no preliminary colostomy has been done, to subject the patient to this procedure at a later date.

Difficulties and dangers. Much the same remarks apply here as after the last operation, although the loss of blood is generally distinctly less. Fæcal contamination of the wound is particularly dangerous during this operation. General septic infection may follow, also necrosis of the sacrum and prolonged suppuration. It must be avoided by devoting sufficient time to the clearance of the bowel before operation and the careful use of clamps and packing during its performance.

After - treatment. The patient will have to be kept lying on his side and much the same treatment must be carried out as after the last operation.

Great care must be taken by an intelligent nurse to prevent contamination of incisions and sutures when the bowels act; the parts should be protected by dressings held by the hand or kept in place by strapping, and careful cleansing must be carried out with an antiseptic solution and drying as often as may be necessary.

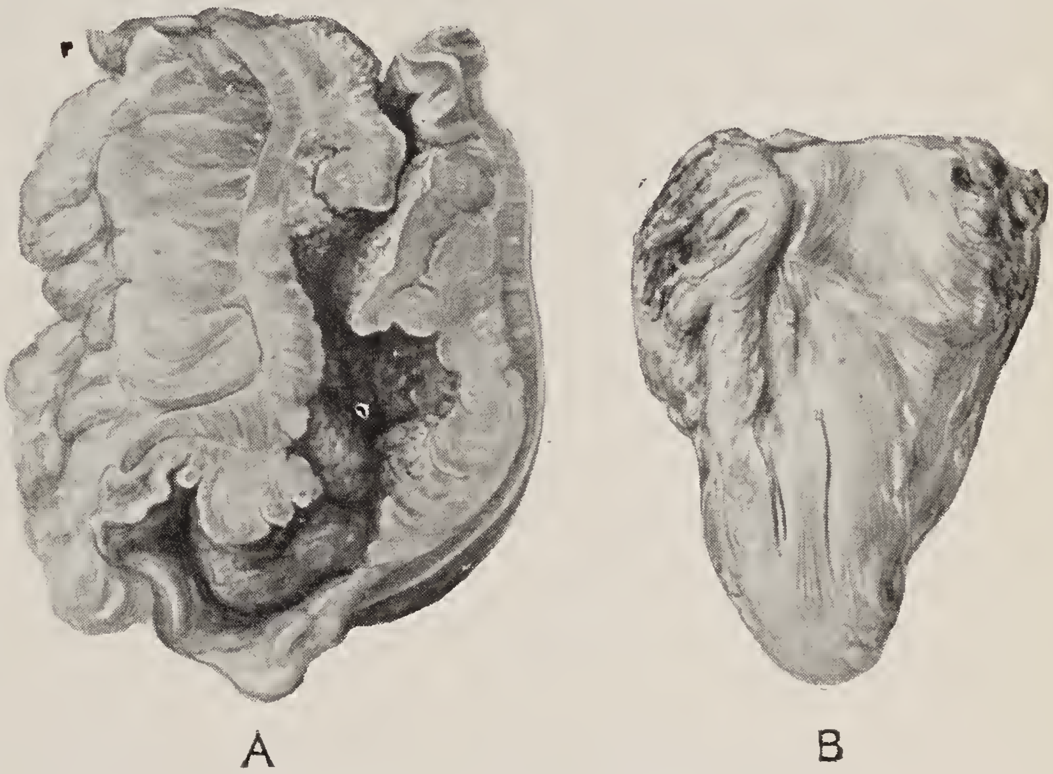

Fig. 72. Parts removed in Parasacral Excision of the Rectum. a, Sagittal section of the carcinomatous bowel after removal; the healthy mucous membrane above the growth has folded backwards and is therefore barely shown; b, Posterior view of the coccyx and portion of the sacrum removed in parasacral excision of the rectum from the same case.

If a sacral anus has been formed the bowels may be opened on the fourth day. Later on, a truss to control the opening is advised by some, but in my experience the patients find them irksome, inefficient, and often painful, and soon discard them.

Complications. Septic infection of the wound may be followed by necrosis of the sacrum, if a portion of that bone has been removed. If the bowel has been united by circular suture, the stitches may give way posteriorly, leading to the formation of a fæcal fistula; this is usual, but in the majority of cases it will close spontaneously. Stricture of bowel frequently follows circular suture. This will be overcome by the careful passage of Hegar's dilators, gradually increasing the size. The removal of too much of the sacrum has caused meningitis with a fatal result.

Results. I have performed this operation eighty-nine times with four deaths, one from peritonitis, one from septicæmia, caused by the wound being flooded by fæcal material, and one from bronchitis and heart failure; the last thirty-three cases have all recovered. Where rectorrhaphy has been carried out, the functions of the bowel have been completely restored, the patients having a normal action and perfect control. This also applies where the upper bowel was brought down through the sphincters and sutured to the margin of the anus; these cases recover quicker than the others, as no fæcal fistula forms. Recurrence must of course depend to a great extent on the malignancy and extent of the growth at the time of operation. Of my first sixty cases of parasacral excision it has been possible to trace fifty. Recurrence took place in eighteen of these—in one after eight years, one after four years, one after three years, in eight after two years, and in seven within the year. Twenty-six were known to be in good health—one after fourteen years, two after four years, four after three years, ten after two years, and nine after one year from the time of operation.

EXCISION BY THE VAGINAL ROUTE

Indications. This is a very good operation in cases of early growth in the lower end of the rectum, also in those where the vagina is involved in the growth.

Operation. The rectum having been emptied and both it and the vagina well douched previously, the patient is placed in the lithotomy position and the rectum and vagina are again washed out with an antiseptic solution. The walls of the vagina are drawn apart with broad retractors, the anterior lip of the cervix uteri is seized with a volsella, and the uterus is drawn downwards and forwards. An incision is then made in the posterior wall of the vagina, from near its upper end above, and deepened below through the perineum till the external sphincter is exposed but not divided. If the vaginal wall be not implicated by the rectal growth, it is easily peeled back on either side and the bowel exposed; but if infiltration has commenced, the affected part must be enclosed in an elliptical incision and removed with the bowel. The rectum is now freely exposed, the levator ani divided, and the neighbouring structures freed from the bowel by blunt dissection; posteriorly the fat and glands are separated from the sacrum with the bowel. If the growth be sufficiently low down it may suffice to push up the peritoneum of the pouch of Douglas; if not, it must be opened and its lateral reflections divided, together with the meso-rectum, close to the bone and as high up as necessary. In separating the bowel above the growth great care must be taken to avoid injuring the superior hæmorrhoidal artery at the posterior aspect of the bowel.

The opening in the peritoneum is now closed by sutures or packing; the former should include the bowel to assist in preventing retraction. The growth is removed by division of the bowel at least an inch above and below the tumour, care being taken to prevent contamination of the wound by clamps or rubber or tape ligatures. After removing the ligature on the distal segment, the anus is dilated and the mucous membrane lining the lower segment is removed from the anal margin upwards, and the lower end of the upper segment is drawn bodily through the collar thus formed, and, after removing its occluding ligature, is sutured with interrupted silkworm-gut sutures to the skin round the anus. Should there be difficulty in drawing down the upper bowel to the anus, and if there be sufficient bowel left above the sphincters for the purpose, the bowel can be united by circular suture. The anterior wall of the lower segment is divided in its long axis, for an inch or so, to facilitate the circular suturing of the two ends; this is begun at the posterior aspect and continued round on each side, taking up all the coats of the bowel. Interrupted No. 2 28-day chromic catgut sutures are used, which are tied on the inner aspect of the bowel. The small vertical incision is then sutured.

When the bowel has been dealt with, any packing removed, and the peritoneum closed by sutures, if this has not already been done, the wound is irrigated with a warm antiseptic lotion, the incision in the vagina is closed with No. 2 14-day chromic catgut sutures, and the perineum repaired. The sutures closing the vagina should include the muscular coat of the rectum, to prevent retraction and lessen the strain on its sutures. The former method of dealing with the end of the bowel is the safer because of the risk of extravasation of bowel contents in circular suture. If the latter method be used, an incision should be made in front of the coccyx and a drainage tube inserted into the hollow of the sacrum, so as to reach to just below the suture line in the bowel. A rubber drainage tube ½ inch in diameter should also be passed up the bowel, and should reach beyond the suture line and project at least 1 inch beyond the anus. It should be retained in position by silkworm-gut sutures passed through the anal skin. The sphincters should be well stretched, and it is safer to divide the external sphincter in order to lessen the strain on the sutures when the bowels are moved.

Difficulties. These are practically the same as after the perineal operation, and the same care must be taken during the after-treatment to avoid giving way of the sutures as after Kraske's operation, when rectorrhaphy has been carried out. The vagina should be douched twice daily with an antiseptic solution.

Results. These have been very good, particularly where the bowel can be brought down through the sphincters and sutured to the margin of the anus. Convalescence is rapid, and some cases have been well within a fortnight.

EXCISION OF THE RECTUM BY THE COMBINED METHODS

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History. This operation was first performed by Czerny, in 1883, for a high-lying rectal growth which he was unable to remove by the perineal route alone. In 1892 Maunsell advised laparotomy, loosening of the bowel above, evagination through the anus, excision of the growth and rectorrhaphy outside the anus. Chaput in 1894, Gaudier and Challot in 1895, Boeckel, Giordano, Quénu, Reverdin, and Tuttle in 1896, all performed combined operations. But it is only since the years 1900 to 1906 that the operation has been advocated on pathological grounds for the majority of all operable rectal cancers.

Pathological Considerations. Owing to a more careful study of the after-results of cases operated on by the routes from below it was found that recurrences appeared in from 60% to 90% of the cases. This led surgeons to investigate more completely the dissemination of rectal cancers, and great stimulus was given to the work by the careful pathological findings of W. E. Miles, Handley, the Mayos, and others.

Three zones of dissemination are now recognized, downward, lateral, and upward. In the downward zone the disease may spread intramurally in the rectal wall below the original growth; or extramurally to the muscular collar of the sphincter, the peri-anal skin, and the fatty tissue of the ischio-rectal fossæ. In the lateral zone dissemination takes place to the precoccygeal and presacral tissues, to the posterior wall of the vagina in the female, or to the sheath on the posterior aspect of the prostate in the male. Also along the fascial tissues covering the levatores ani muscles, and even in the substance of the latter plaques of growth have been found. In the upward zone the disease may spread intramurally in the rectal wall above the original growth, and extramurally in the lymph-vessels and tissues of the pelvic mesocolon up to the lymph-glands at the bifurcation of the left common iliac artery, and even higher. The peritoneum may become affected. Embolic dissemination in the liver may also occur, and this is a factor which at present we do not quite understand, as it may occur in quite small, movable, and otherwise operable growths of the rectum, or it may not occur till late in the progress of the disease. With regard to the invisible intramural spread Handley has shown by means of the mucicarmine method, in which cancer-cells undergoing mucoid degeneration take up the stain, that for many inches on either side of the original growth cancer-cells are to be found spreading intramurally in the submucous lymph plexus. Later investigations by Cole show that the cancer-cells tend to permeate by radial intramuscular channels to a deeper lymph plexus where dissemination may take place to a considerable extent. This intramural invisible dissemination is supported by clinical evidence in cases where recurrence takes place in the bowel-end or at the colostomy opening, many inches above the original growth. But it is now generally recognized that extramural dissemination is of much more importance than intramural. The more complete knowledge of the pathological extension of rectal carcinoma forms the basis of the modern combined or abdominal-perineal operation which has been designed for the removal *en masse* of the original growth, and as far as possible its three zones of dissemination. This places the treatment of rectal cancer on the same footing as that of cancer in any other removable area, *e.g.* the mammary gland. Deposits of growth in the liver or peritoneum of course render the operation inadvisable.

Indications. This is the operation of choice in high-lying rectal growths, but in advocating this procedure for all operable rectal cancers irrespective of position many factors have to be taken into consideration, such as sex, age, general condition, and finally the individual patient's own views and desires.

Sex is an all-important point. The mortality after this operation in the female is very much less than that in the male. The operative procedure is rendered so much easier in the wider pelvis of the female than in the male, and in the latter extension of the disease in the region of the prostate makes complete eradication very difficult.

Age is a more difficult question to discuss. I am convinced that rectal cancer in the young is of an extremely malignant type, and therefore the combined operation is indicated. With regard to elderly patients some surgeons have performed the operation in cases over sixty years of age with good results, although Miles at present does not operate on a case over that age.

The general condition of the patient is of extreme importance and careful selection of cases should be made. They should have no renal, cardiac, or pulmonary disease, and be fairly free from arterial degeneration. Obesity is rather a contra-indication, as the operation is so much easier to perform in spare subjects.

Then finally the views and desires of the patient must be considered. The surgeon must explain to the patient or responsible relative the nature of the disease, and the danger incurred if left untreated. The seriousness and mortality of the combined operation must be discussed. The patient should understand clearly the nature of a permanent colostomy (or perineal anus, as the case may be). Some surgeons give their patients the choice of having either the combined operation or one by the lower route only, after explaining the seriousness of the former with regard to immediate danger to life, and the seriousness of the latter with regard to recurrence. As no hard-and-fast lines can be drawn, the surgeon in giving his final advice to the patient on the choice of methods must judge each case on its merits.

On the other hand, some surgeons, convinced of the futility of attacking the disease only from below, advise that only the combined method should be performed. The time is not yet ripe to discuss fairly the merits of the two methods, but the more one sees of the disease treated by the lower routes the more one notes the high percentage of recurrences. The truth of the matter lies in the fact that in cancer of the rectum there are two types. One, more frequently met with and of high malignancy, which tends to early extramural spread, and which therefore surely recurs unless complete eradication of the zones of spread is carried out as in the abdomino-perineal operation; the other type, less frequently met with and less malignant, in which extramural spread does not readily occur and which is submitted to operation by one of the lower routes does not show recurrence. Even the extramural spread in the latter seems only slightly malignant, for we know of cases in which the rectum has been excised by the lower route, with only a small margin of bowel on either side of the growth, and leaving presumably involved glands and perirectal tissue; and yet such cases have shown no recurrence many years afterwards. Nature would appear to be able to deal with what is left in such cases. Unfortunately we have no means—histology helps only to a slight extent—by which we can distinguish one type from the other. And as at present radium, sera, rays, and drugs have all failed to cure rectal cancer, and our only hope is the knife, it would help us to use that instrument with greater confidence had we some means, *e.g.* a blood reaction on the Wassermann lines, or some other test, to distinguish the types.

Preparation before operation. The patient must be in the home or hospital at least fourteen days before the operation. Pyorrhœa alveolaris, oral sepsis, vaginal discharges, and other septic foci must be treated. The patient should have the bowels moved once a day by means of a saline laxative. A rectal wash-out is given daily, first of hydrogen peroxide followed by boric lotion. Undue and severe purging must be avoided, as this considerably weakens a patient who requires all his reserve power to withstand the serious operation ahead of him. Easily-digested concentrated foods should be given which leave little residue. Salol or beta-naphthol may be given by the mouth and anti-coli vaccine may also be employed.

The Exploratory Laparotomy. The patient is placed in the high Trendelenburg position, and the abdomen opened in the mid-line for three and a half inches between the umbilicus and the pubes. The hand is inserted and the liver examined first of all. Opportunity may be taken here of strongly advocating an exploratory laparotomy in all seemingly operable rectal cancers, no matter what route or what operation is to be employed. Many cases have been operated on by the lower routes which not long after showed clinical evidence of liver involvement; and these patients would have been saved the trouble and danger of an unnecessary operation had the abdomen been opened in the first instance as in the first stage of the abdomino-perineal method.

However, it must be remembered that even when the abdomen has been opened the liver may be involved and yet this condition may not be discovered by the examining hand. One of two factors may account for this. Firstly the metastatic deposit may be fairly large, single, and placed centrally in the liver substance (an excellent specimen in St. Mark's Hospital Museum illustrates this); or, secondly, the metastases may be only in the microscopic stage at the time.

After the examination of the liver is completed the peritoneum is next examined, then the amount of glandular enlargement noted, and finally the extent, position, and connexions of the growth are made out from above. This completes the exploratory part of the operation. The actual removal of the diseased rectum may be carried out in three different ways, and these are named as follows:

(*a*) The abdomino-perineal operation originated by W. E. Miles, which consists in removing the rectum, the greater part of the pelvic colon, and the zones of dissemination; and using the upper part of the pelvic colon to establish a permanent iliac colostomy.

(*b*) The abdomino-anal operation, which consists in the removal of the rectum and lower part of pelvic colon, and then implantation at the anal margin of the divided end of the upper part of the pelvic colon which is made free from above.

(*c*) The abdomino-sacral operation, in which the upper part of the rectum and lower part of the pelvic colon are removed, the sphincters and lower part of the rectum being saved, and the divided end of the latter sutured to that of the upper part of the pelvic colon.

Of these three methods *the abdomino-perineal operation is the only one to be recommended,* as by it complete removal of the zones of dissemination is effected. In the abdomino-anal and abdomino-sacral operations the zones of dissemination are not completely removed, and the question of efficient vascular supply to the new-formed rectum is frequently uncertain, so that although a brilliant result from these methods is now and then recorded they are pathologically unsound, and are not to be advised.

The Abdomino-perineal Operation. The mid-line abdominal wound is enlarged till it extends from the pubes to a little above the umbilicus and the edges of the incision are held apart by a self-retaining abdominal retractor. The intestines are gently packed out of the way into the upper part of the abdominal cavity.

The pelvic colon is now held up by an assistant, its mesocolon put on the stretch and its vessels viewed by transmitted light. Just below the bifurcation of the aorta, at the level of the upper part of the left common iliac artery, the inferior mesenteric artery is felt pulsating immediately behind the parietal peritoneum; and one inch to the right of this the peritoneum is incised and stripped to the left till the inferior mesenteric trunk is exposed. Here it is ligatured in two places, at a spot between the origin of its upper sigmoid branch and the origin of its middle sigmoid branch, thus ensuring good vascular supply to the upper part of pelvic colon which goes to form the colostomy. The inferior mesenteric artery is now divided between the double ligatures, and the inferior mesenteric vein, which lies a little to the left of the artery, is similarly treated. In most cases it lies near enough to the artery to be included in the same ligature. Just to the left of this the ureter is exposed and carefully avoided. The pelvic mesocolon is now divided from behind forward to the bowel edge, all vessels being clamped and tied.

After packing carefully around to prevent soiling, the pelvic colon is clamped in two places three inches apart, and the bowel ligatured in two places between the clamps. By means of the actual cautery the bowel between the ligatures is divided, and both ends are invaginated and closed over by purse-string sutures. If preferred, the bowel may be crushed by a powerful clamp, then ligatured and invaginated. The upper part of the pelvic colon is now turned upwards till a later stage in the operation when it is used for the iliac colostomy.

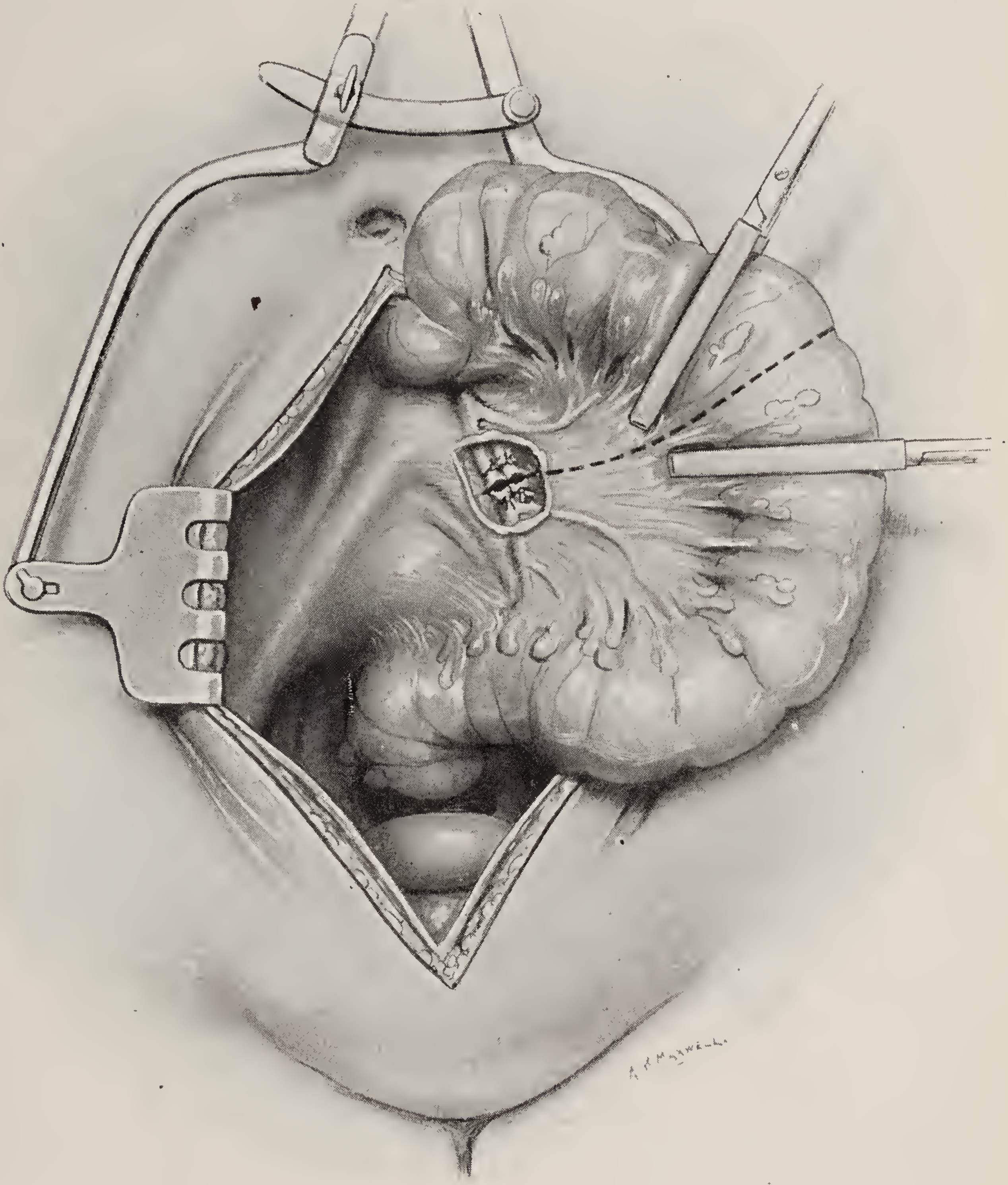

FIG. 73. ABDOMINO-PERINEAL EXCISION OF THE RECTUM. *Ligature of the inferior mesenteric vessels.* The dotted line shows where the pelvic colon and mesocolon are to be divided.

At a distance of one inch on either side of the point of ligature of the inferior mesenteric artery incisions are made in the peritoneum and carried downward into the pelvis, parallel to and one inch on either side of the parietal attachment of the pelvic mesocolon. Great care must be taken of the ureters, especially the left, which is seen and felt running down a little laterally to the peritoneal incision. The incisions are carried down till the recto-vesical pouch is reached, and are then brought round to meet in front behind the base of the bladder. In the female the left ovary, tube, and broad ligament may be removed at this stage. By means of the hand separation is now carried down in front of the sacrum and coccyx, keeping close to the bone. In front, detachment from the bladder by long scissors is continued till the upper limit of the prostate is reached. In separating the lateral attachments great care must be taken of the ureters, and they are better traced down as far as the base of the bladder. This as a rule need only apply to the left ureter. With the ureters protected, lateral separation is now continued without fear till the levatores ani muscles are reached. It is advisable to do as much separation as possible from above during the abdominal portion

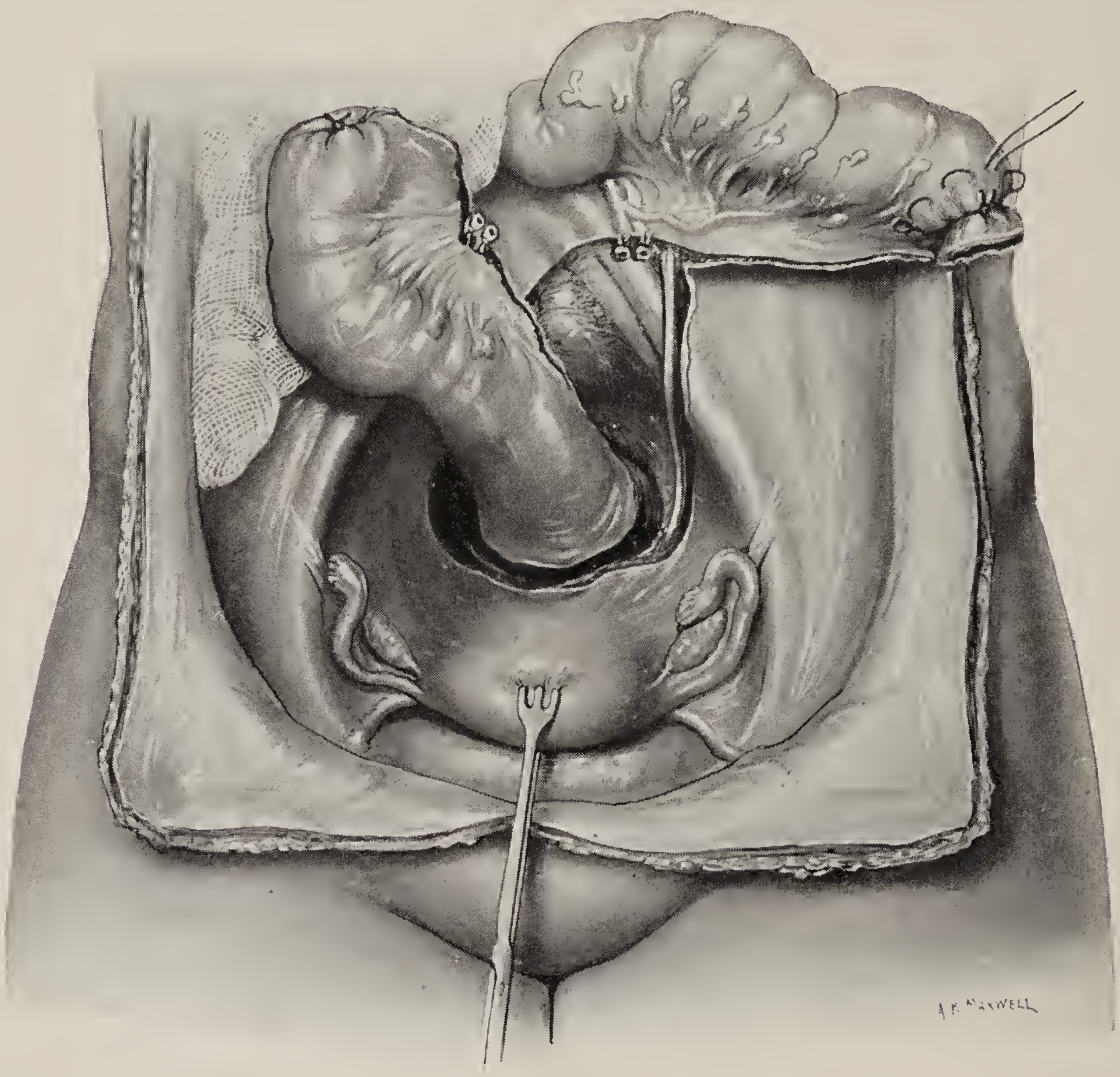

Fig. 74. Abdomino-perineal Excision of the Rectum. *Division of the pelvic colon.* The lines of the peritoneal incisions are shown, and the separation of the lower part of the pelvic colon and the rectum has been carried down to the level of the levatores ani. The left ureter is seen crossing the left common iliac artery.

of the operation as this facilitates the subsequent procedure from the perineum. The freed structures are now crowded down into the pelvis and covered by thin packing. The peritoneal gap is next repaired by suturing the peritoneal edges, commencing above and completing the line of suture by restoring the pelvic peritoneal floor. In doing this latter some difficulty may be met with in getting the peritoneal edges to meet without undue tension, but in the female use can be made of the uterus by retroverting it to close the pelvic floor or if the omentum be long enough it can be brought down to fill the gap. Care must be taken to leave no fossæ in which small intestine may be caught. The remaining upper portion of pelvic colon is now brought through a stab-wound in the iliac region and sutured there.

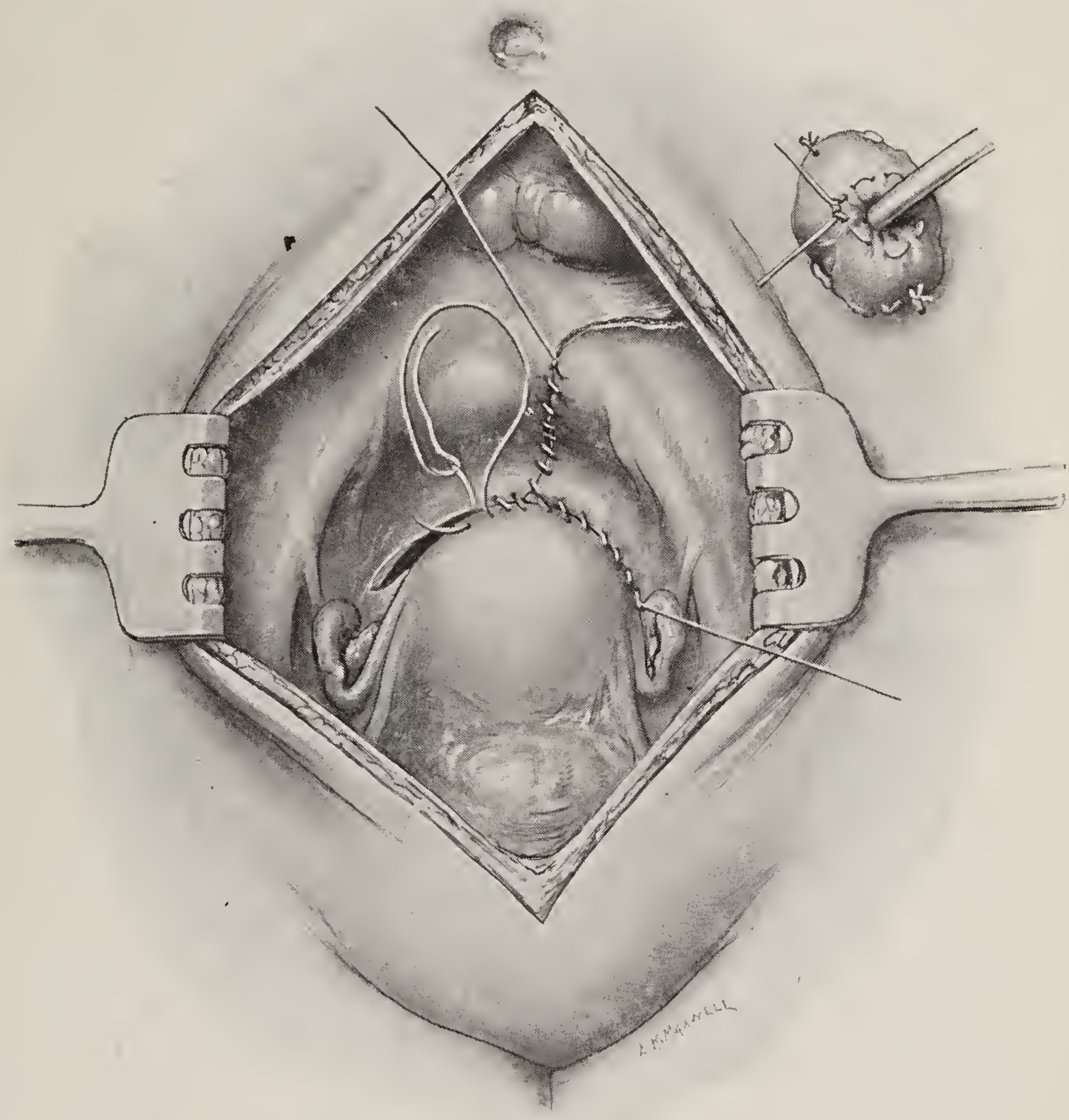

FIG. 75. ABDOMINO-PERINEAL EXCISION OF THE RECTUM. *Completion of the abdominal stage of the operation.* The colostomy has been established and the pelvic peritoneum is being sewn up.

Two pints of hot saline are gently poured into the abdominal cavity and the abdominal wound closed. A soft rubber catheter is introduced through a puncture into the lumen of the projecting blind end of bowel which forms the colostomy, and the bowel sutured round it by two tiers of purse-string sutures, the catheter being clamped to prevent leakage. The wounds are protected by dressings and the abdominal portion of the operation is complete. The table is now lowered from the Trendelenburg position and the patient placed in the left lateral position with the pelvis raised. The anal orifice is closed by a purse-string suture. A transverse incision three inches long is made over the sacro-coccygeal joint, and from the centre of this another incision at right angles is carried down to within one and a half inches of the anus, where the incision is made to bifurcate, widely encircling the anus, to be joined again in front at the central point of the perineum by another transverse incision. The skin-margins are reflected a little and the coccyx exposed, disarticulated, and removed. The interval between the levatores ani muscles is defined, and the hand inserted into the wound and the packing and the freed pelvic colon and upper part of rectum are drawn out through the wound. Dissection is now carried out laterally, removing widely the ischio-rectal fat and detaching the levatores ani muscles from their attachment at the pelvic wall, all vessels being crushed and tied if necessary. When the sides are free the rectum is dissected from above off the posterior surface of the prostate, and if need be the sheath of the latter is removed. The incision at the central point of the perineum is deepened till the remaining tissue in front of the sphincter collar is

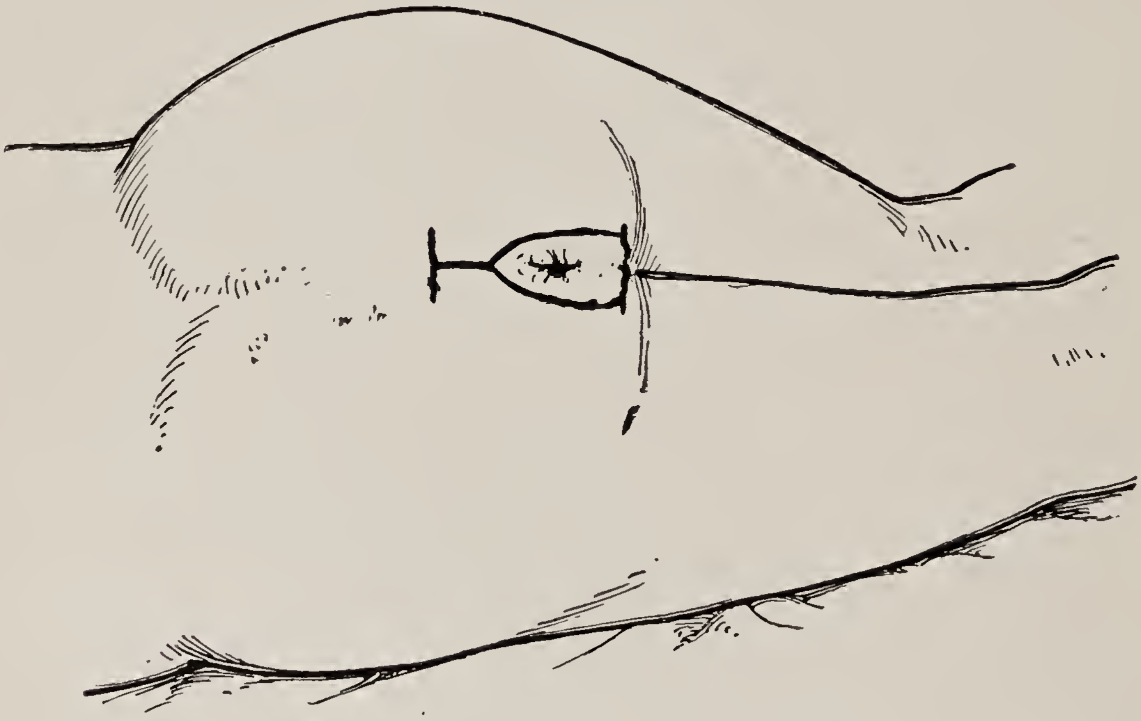

FIG. 76. ABDOMINO-PERINEAL EXCISION OF THE RECTUM. *The lines of incision for the approach from below.* The anal orifice is closed by means of a purse-string suture.

divided. The diseased bowel with all its zones of dissemination is now completely free and is removed *en masse.* Gauze packing covered by silk oil-skin, to prevent subsequent adherence to the structures above, is inserted to fill the gap, and a large drainage tube is placed in front and made to project at the lower angle of the wound. The wound is partly sutured and dressings are applied.

The Abdomino-anal Operation. Hartmann demonstrated that division of the superior hæmorrhoidal artery just above the promontory of the sacrum, immediately above the origin of its lowest sigmoid branch, ensures good vascular supply to the pelvic colon so that it may be safely drawn down and implanted at the anal margin. It had also been shown that one of the chief factors causing inability to draw the pelvic colon down to the anus is the attachment of the sigmoid branches of the inferior mesenteric artery and its continuation the superior hæmorrhoidal. In the abdomino-anal operation the latter artery is dissected

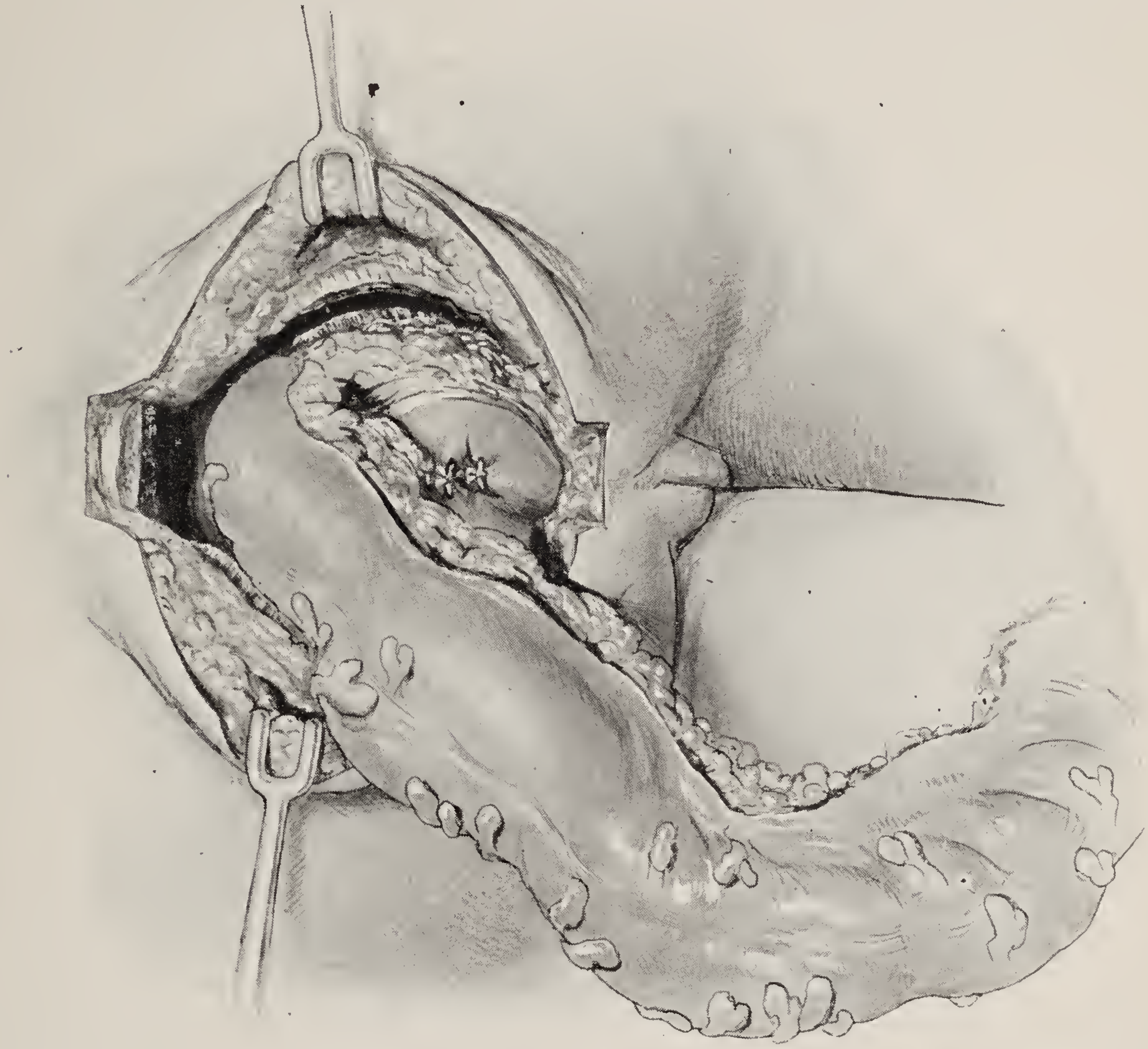

Fig. 77. Abdomino-perineal Excision of the Rectum. *Removal of the bowel from below.* The pelvic colon and rectum have been pulled down out of the pelvis and the dissection for freeing the lower end of the gut is shown.

free above the promontory and divided between two ligatures. The peritoneum on either side of the pelvic mesocolon is incised and detachment carried on behind, laterally, and in front (as in the previous operation), till the pelvic colon is so mobilized that six inches of it can be drawn down without tension below the level of the left common iliac artery. The mobilized bowel is crowded down into the pelvis and the pelvic peritoneum is sutured round the colon, thus closing the pelvic floor. The abdominal wound is now closed, and the patient placed in the left lateral position. An incision about three to four inches long is made in the median line over the sacro-coccygeal region and the coccyx removed as before. The rectum is freed down to the upper border of the sphincter collar, behind, then laterally and finally in front from the posterior surface of the prostate. This dissection is facilitated by drawing the mobilized pelvic colon and upper part of the rectum out through the sacral wound. The lining of the anal canal is now dissected from below, as in Whitehead's operation for piles, till it is quite free and can be drawn out at the sacral wound. The diseased bowel is now removed outside the wound by dividing the pelvic colon at the level which is to form the new anus, and the latter is drawn down within the sphincter collar and sutured to the anal skin-margin. The operation is completed by suturing the sacral wound and leaving a drainage tube in it.

The Abdomino-sacral Operation. This method can only be used when the lower part of the rectum and anal canal are free from disease. The procedure in the abdomen is the same as in the abdomino-anal operation. After closing the abdomen the patient is placed in the left lateral position and a sacral wound made as in Kraske's operation. The coccyx is removed, and the lower part of the sacrum if necessary. The mobilized pelvic colon is brought out through the wound, and the bowel divided as far on either side of the growth as possible and removed. The divided end of the pelvic colon is now brought down to the divided end of the rectum and a colo-rectorrhaphy performed. In this operation the lower part of the rectum and the sphincters are left intact. To complete the operation the sacral wound is sutured, leaving ample drainage. The technique of this operation may be modified by leaving the loop of bowel with its contained growth outside the sacral wound for 48 hours, and then after examination of its blood-supply, excising the growth and performing end-to-end suture.

In the abdomino-anal and abdomino-sacral methods the sphincteric control is preserved, but there is no wide and thorough removal of the zones of spread as in the abdomino-perineal method.

After-treatment. The patient is placed in bed lying on his side in the horizontal position. Shock is combated by saline solution intravenously, subcutaneously, or through the catheter which is tied in the colon as the case may require. Strychnine and pituitary extract may be given subcutaneously. Oxygen which is made to bubble through alcohol is administered at intervals. The extremities are encased in cotton-wool and bandaged. On the day following the operation the outer dressing on the perineal wound is changed, and on the second day the gauze packing is removed (under gas anæsthesia if necessary). Before repacking the wound the sigmoidoscope may be passed into it and the pelvic floor examined from below. The colostomy acts or is made to do so about the third day, and the diet then markedly increased. The sutures in the abdominal wall are removed on the fourteenth day. The perineal wound is irrigated and cleansed daily, and as the gap slowly fills in the packing and tube are both shortened.

Difficulties and Dangers. The difficulties to be met with arise from both anatomical and pathological causes. They are not common, but the following may be encountered: narrow pelvis—especially in the male; shortness of the mesocolon; variations in blood-supply to the pelvic colon; and adhesions in the peritoneal cavity binding down intestine, or matting the parts together.

The dangers are sepsis, hæmorrhage, and injury to important structures. Sepsis should be avoided by careful technique. Hæmorrhage should not be serious, and is usually most troublesome in separating the lateral attachments of the rectum deep down in the pelvis, and also when the sheath of the prostate requires removal in the perineal part of the operation. The most important structures liable to injury during the operation are the ureters, especially the left one. This should be seen, felt, and traced downwards and forwards on the lateral wall of the pelvis as far as the base of the bladder. Care must be taken not to separate it too much from its bed, as this may seriously affect its nutrition. The ureters may be catheterized before operation, but this precaution is rarely necessary. I have injected methlyene blue intra-muscularly before the operation in the hope that the colour would show through the ureter, but the muscular walls proved too thick.

Complications. Some cases never recover from the severe shock. Sudden cardiac failure and pulmonary embolism account for some deaths. Sepsis is a serious complication, and deaths from peritonitis occur. Paralytic ileus sometimes follows the operation.

The pelvic floor may give way, allowing prolapse of the intestine, with subsequent septic infection or strangulation. Straining during vomiting is a frequent cause of this accident.

Stenosis in the anal canal may occur after the abdomino-anal operation, and the formation of an anterior spur and persistent sinus after the abdomino-sacral method.

Results. The mortality following this operation is undoubtedly very high. I would place it at 55%. If the patient survives until the fifth day he may be considered likely to recover.

It is too early to judge fairly the late results. Recurrences have been fairly frequent after the abdomino-anal and abdomino-sacral methods. The abdomino-perineal method has given the best results, but recurrences have been noted.

Note by Mr. Swinford Edwards

I am thoroughly in accord with the views of my friend and colleague, Mr. Anderson, concerning the indications for the combined operation, and should like to emphasize the statement "that every case must be judged on its own merits." I laid stress on this when I had the honour of introducing a discussion on the Operative Treatment of Cancer of the Rectum, at a meeting of the Surgical Section of the Royal Society of Medicine in 1912.

I do not consider it justifiable—especially in the male—to submit cases of small and early carcinomata situated in the rectal ampulla to the risks of the abdomino-perineal operation, when a good prospect of a cure may be obtained, and this, in many cases, with the use of the normal anus by a parasacral or coccygeal operation, attended, as this operation is in my hands, with a mortality of only 5%, whilst recurrence has been almost nil in these early cases.

By insisting on an operation attended by an immediate mortality of say 50%, together with the nuisance of an abdominal anus, many sufferers would refuse operation, and thus lives would be sacrificed which might otherwise be saved.

I have performed the combined operation on six females with no death and one recurrence, and on one male who died of exhaustion on the tenth day. I consider it a very serious operation in all males and absolutely fatal when obesity is marked.

CHAPTER VI

OPERATIONS FOR STRICTURE OF THE RECTUM

Prior to subjecting a patient to any of these operations, care should be taken to ensure a thorough evacuation of all intestinal contents, for which purpose a week is often needed; during this time, in addition to the administration of purgatives, frequent enemata should be given; and, if they do not pass above the stricture, it can usually be dilated sufficiently to enable them to do so, but if ineffective, a preliminary colostomy is certainly called for. The bowel should be well irrigated with non-poisonous antiseptic solutions. Intestinal antiseptics should be given by the mouth, such as salol, gr. 10 twice daily; if procurable, the Bulgarian lactic acid bacilli are more effectual. The diet should be the same as that recommended after operation.

DILATATION BY BOUGIES

Indications. As in the analogous condition of the urethra, favourable conditions for treatment are more likely to be present—

(i) In recent cases.

(ii) When the stricture is low down and of slight or moderate extent.

(iii) When adjacent parts are not involved.

Operation. The dilatation must be conducted with great care on the part of the surgeon, and it is necessarily a tedious process, generally requiring several months for its accomplishment. No force should be used in introducing the bougie, especially when the stricture is in that part of the bowel which is covered by a reflection of peritoneum. Neglect of this precaution has been followed by fatal results, due to rupture of the peritoneal coat. The gum-elastic instruments are of various sizes, and the conical form is the most suitable. Of late years I have found conical metal dilators, such as gynæcologists use for dilatation of the cervix uteri, which are known as Hegar's dilators, of much service. These dilators have either a single or a double curve, which greatly facilitates their passage. Moreover, they can be easily sterilized. The cases in which I have found these dilators of special use are those in which a narrowing of the rectum has taken place owing to the formation of an anterior spur after rectorrhaphy following the operation for removal of malignant disease.

Supposing that the stricture is within 3 inches of the anus, a bougie of suitable size, previously warmed and well lubricated, should be passed through it and allowed to remain *in situ* for at least half an hour. The patient should be kept in bed, and the introduction of the bougie should be repeated on each succeeding day until the stricture is permeable to its full extent; a bougie of the next larger size should then be used, and so on until the requisite amount of dilatation is effected.

In the case of annular stricture, near the anus, this dilatation may be facilitated by making a few *incisions* through the indurated tissues, and by using Todd's dilator (see Fig. 78) or a bivalve speculum. These incisions should not be too deep, and three or four are usually sufficient. As some hæmorrhage always occurs, a hollow vulcanite tube, open at both ends, should be introduced, and retained for forty-eight hours. Subsequently a bougie is passed daily, and afterwards a dilute solution of potassium permanganate, chinosol, or boric acid should be used as an injection.

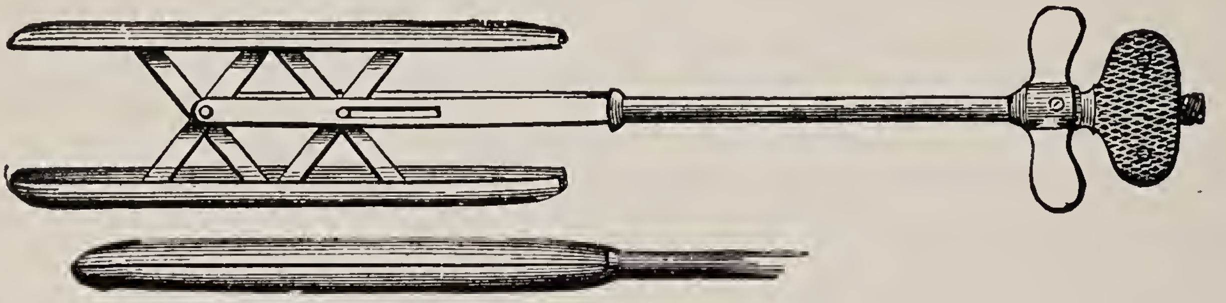

Fig. 78. Todd's Rectum Dilator.

In cases in which the stricture is beyond the reach of the finger the difficulties are much increased. The bowel should be carefully examined by means of the proctoscope or sigmoidoscope. The position, length, and other characters of the stricture having been ascertained, attempts may be made to dilate it by passing a conical bougie through a Kelly's proctoscopic tube, the patient being in the genu-pectoral position. When the point of the instrument has entered the stricture, it will be more or less closely gripped thereby; no force is permissible, as there are several cases on record in which the bougie was driven through the bowel, with fatal peritonitis as a result. Peritonitis, indeed, may be set up in the absence of perforation. When the stricture has been reached, the bougie should be allowed to remain *in situ* for a few minutes or even longer, the proctoscopic tube being withdrawn over the bougie. The patient is of course to be kept in bed and at rest, and all due precautions must be adopted with regard to diet.

Difficulties and dangers. Rupture of any of the coats of the bowel may be followed by proctitis, periproctitis, or peritonitis. These are to be avoided by introducing instruments of suitable size with the utmost gentleness, and by devoting sufficient time for the proper emptying and cleansing of the bowel before operation, and by antiseptic irrigations afterwards.

After-treatment. The patient should be kept in bed, at least till dilatation is well advanced, and the bowel should be irrigated several times daily with non-poisonous antiseptic solutions. The diet should consist of food which will leave little residue, such as has been recommended to be given before excision of the rectum on p. 133.

The above remarks on dangers and after-treatment also apply to the following operations for stricture of the rectum.

When dilatation is accomplished, the patient's symptoms are much relieved, the bowels act more comfortably and regularly, and with little or no straining. It must, however, be remembered that a relapse is very liable to occur, unless the bougie be passed at regular intervals for some months or years after the dilatation has been effected. The patient's diet also requires careful attention, and everything which tends to irritate the bowels must be avoided. Constipation, if present, is to be dealt with by laxatives, such as castor oil or the compound liquorice powder. If there be dyspepsia and flatulence, bismuth and soda are indicated.

LINEAR INCISION

Indications. This is the best method we have for dealing with annular strictures of the linear variety when situated well within reach of the finger, *i.e.* anywhere below the peritoneal reflection.

Operation. The patient being in the lithotomy position, the sphincter should be forcibly dilated. The left index-finger is then passed up to or through the stricture, carrying with it a probe-pointed straight bistoury; and three or four limited incisions are made through the stricture, dorsally, bilaterally, and even anteriorly. A sheathed Todd's dilator is then introduced, and the blades expanded to the requisite extent, *i.e.* in most cases sufficiently to permit the introduction of a No. 10 conical rectal bougie; and the operation is completed by the insertion of a No. 8 or 9 hollow vulcanite tube with a flange (see Fig. 60). This maintains dilatation, arrests bleeding by pressure, discloses concealed hæmorrhage if present, and permits the passage of flatus. It should be retained, if possible, for at least forty-eight hours. As a rule but little bleeding takes place at this operation; but, if the bleeding should be at all severe, any bleeding vessels should be secured and tied: should this not be possible, such bleeding can be arrested by firmly plugging with gauze strips, using the vulcanite tube as a *point d'appui*. This operation is particularly fitting for low-lying strictures of traumatic origin, such as sometimes follow an operation for hæmorrhoids.

After-treatment. This consists in the daily passage of a bougie, and irrigation with some antiseptic fluid through the bivalve speculum, until the wounds have healed. The passing of the bougie may then take place at increasing intervals.

INTERNAL PROCTOTOMY

Indications. It should be employed in strictures higher up the rectum, when of an annular or limited tubular form.

Operation. This is really a similar operation to the foregoing; but one incision only is made, in the mid-line dorsally. This incision should cut through the whole thickness of the stricture. The steps of the operation, and the after-treatment, are the same as above detailed; except only that to avoid the locking-up of secretions in a large and deep incision it is as well not to rely upon forcible dilatation of the anus, but to substitute a subcutaneous division of the external sphincter. In this operation, if bleeding be not sufficiently arrested by the vulcanite tube, the addition of tampons of gauze will usually prove effectual.

EXTERNAL PROCTOTOMY

Indications. Where there is a considerable quantity of inflammatory thickening surrounding the strictured portion of the bowel.

Operation. The strictured part of the bowel is divided longitudinally through a dorsal skin incision, the patient being in the left semi-prone position. If necessary, the coccyx and even the lower segment of the sacrum may first be excised. The strictured bowel is then freely divided by a longitudinal incision in the middle line. Buried chromic catgut sutures are then passed through the superficial layers of the gut, the wound in the bowel closed longitudinally, and the skin wound closed, with provision for drainage. In this way, the cicatricial tissue which forms the stricture is left ununited. A drainage tube should be inserted through the anal canal, and retained there, to provide for the escape of flatus and discharges.

Results. The only drawback to this operation is that a fæcal fistula is often the result, which may necessitate a plastic operation for its closure. Its advantages are that the sphincter is not divided, and that, the wound being open, hæmorrhage is easily controlled.

COMPLETE LONGITUDINAL DIVISION (LINEAR PROCTOTOMY)

Indications. This operation is suitable for a long tubular stricture, extending from the anal canal upwards for even 3 or 4 inches, especially for cases complicated by fistulæ.

Operation. The patient being placed in the lithotomy position, the operator passes his left forefinger as far as possible into the rectum, through the stricture if this be permeable, and if not, as far as its commencement. A curved sharp-pointed bistoury is introduced along the finger, and the edge is then turned towards the sacrum. The point is made to transfix the bowel, if possible above the stricture, and is brought out through the skin at the tip of the coccyx, all the intervening tissues being thus divided. If the upper part of the stricture has escaped division, the edges of the wound should be held apart with retractors and the division completed with knife or scissors, under the guidance of both finger and eye. Thus a triangular gap is made with the apex above and the base below. After all bleeding has been stopped, the wound is well flushed with 1 in 2,000 perchloride of mercury lotion and packed with gauze after the insertion of the rectal tube. There need be no fear of severe hæmorrhage, provided that the incision be made in the median line. If, however, any bleeding should occur which cannot be arrested in the ordinary way, the tube and strips of gauze should be inserted as before described.

After-treatment. The wound must be syringed night and morning with a non-poisonous antiseptic solution and lightly packed with cyanide gauze.

Dilatation by means of bougies must be persisted in for a considerable time after this and the above operations, or re-contraction will take place.

SECTION III

OPERATIONS UPON THE DUCTLESS GLANDS

PART I

OPERATIONS FOR TUBERCULOUS DISEASE OF THE LYMPHATIC GLANDS

BY

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CHAPTER I

OPERATIONS FOR THE REMOVAL OF TUBERCULOUS CERVICAL GLANDS

In performing operations for tuberculous disease of the cervical glands an intimate knowledge of the anatomy of the neck is all-important. If the operator knows exactly where to expect each anatomical structure before it is exposed, he will know when he may use the knife freely and when he must use it cautiously. When all the group of glands which go to form the deep cervical chain are involved the operation is necessarily a tedious and arduous one, and whether it occupies two hours or only one will depend very largely on the anatomical knowledge of the operator. Lack of this knowledge is often responsible for unnecessary injury to important structures, for recurrence—due to incomplete removal of the disease—in short, for bringing into discredit an operation which is performed too seldom rather than too frequently, and which, moreover, is often too long postponed. It must be remembered, too, that the disease is generally much more extensive than the clinical appearances might lead one to suppose. The operation is by no means of the minor nature which the patient is unfortunately often led to believe. Besides the glands which are visibly and palpably enlarged there are almost invariably others situated more deeply, which, although smaller, are nevertheless diseased.

SURGICAL ANATOMY

Before proceeding to describe the various operations for the removal of tuberculous cervical glands it will be necessary to refer shortly to the anatomy of the various groups of glands, and to their relations to the more important structures which have to be dealt with in the course of the operation. Each group receives its lymphatics from definite regions, and by noting the position of the glands first involved the peripheral source of infection can often be discovered. The spread of the disease from one glandular group to another is due to the fact that the efferent lymphatics from one group form part of the afferent vessels going to the group situated proximal to it; hence the disease may spread so as to involve the entire deep cervical chain.

The following short account of the topography of the glandular groups and the areas which drain into them is founded mainly on the work of Delamere, Poirier, and Cunéo. According to these authors, the glands of the head and neck are arranged into two main systems; the one forms a circular chain at the junction of the head and neck, while the other consists of a right and left vertical chain, each of which descends under the sterno-mastoid and accompanies the internal jugular vein from the base of the skull to the root of the neck.

The pericervical glandular circle is made up of the following groups, placed in the following order from before backwards; the submental, the submaxillary, the parotid, the mastoid, and the occipital.

The *submental glands* lie on the mylo-hyoid muscle between the anterior bellies of the digastric muscles. Sometimes they lie nearer the hyoid bone, and when in the latter situation they are referred to as the suprahyoid glands. They receive their lymphatics from the skin of the lower lip and chin, and from the mucous membrane of the tip of the tongue and the anterior part of the floor of the mouth. When tuberculous, they are rarely alone involved; more frequently they are diseased along with the submaxillary glands. Their efferent vessels drain to the anterior group of the upper deep cervical glands on both sides of the neck; hence it is not uncommon to find the glands in both carotid triangles diseased secondary to the submental glands.

The *submaxillary glands* are confined to the digastric triangle. Like the preceding group they lie beneath the general envelope of cervical fascia. Those in front and behind the submaxillary gland are tucked up under cover of the mandible, the posterior set being closely related to the facial artery and to the junction of the facial with the anterior division of the temporo-maxillary (posterior facial) vein. For practical purposes, we must consider, along with the submaxillary group, the gland which lies on the outer aspect of the mandible in close contact with the facial artery. The submaxillary glands receive their afferent vessels from the anterior part of the face including the inner half of the conjunctiva and orbit, from the nose, from the mucous membrane of the mouth including the teeth and gums, and from the anterior part of the tongue. The efferent vessels drain into the same glands as the submental.

Of the *parotid lymphatic glands* one or two (preauricular) lie just in front of the tragus, immediately beneath the parotid fascia. A number of others are scattered through the substance of the gland; they are separated from the submaxillary lymphatic glands by the stylo-maxillary ligament. Along with these intraparotid glands are to be included a small group known as the *superficial cervical* or *subauricular glands.* These form a short chain which lies along the anterior border of the sterno-mastoid in contact with the commencement of the external jugular vein; when enlarged they form a swelling immediately below the auricle and fill up the space between the jaw and the mastoid process

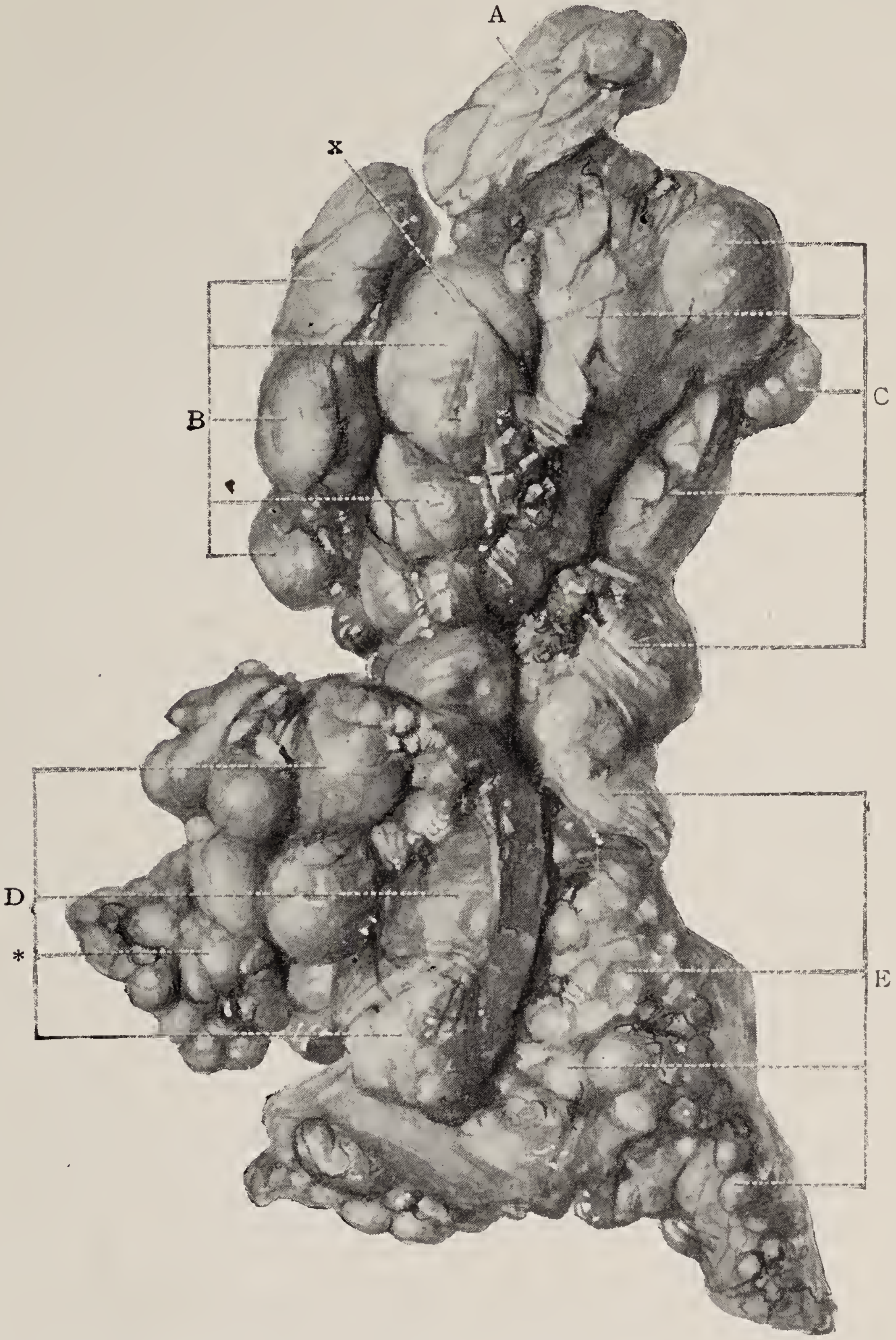

Fig. 79. Tuberculous Glands removed from the Left Side of the Neck of a Female aged Twenty-three. The mass was excised through two oblique incisions, an upper and a lower. A similar mass was removed from the right side of the neck by the J-shaped incision shown in Fig. 82. A, The superficial cervical (subauricular) group; B, The upper anterior group, the gland indicated by the × being the tonsillar lymphatic gland; C, The upper posterior group; D, The lower anterior group; the subsidiary cluster indicated by the * lay in front of the vertebral vein in close relation to the thoracic duct, from which it was separated; E, The lower posterior (supraclavicular) group, the tail-like postero-inferior projection of which dipped under the trapezius and clavicle and lay upon the upper digitation of the serratus magnus.

(see Fig. 79, A). The parotid lymphatic glands receive their efferent lymphatics from the outer and middle ear; from the skin of the frontal, parietal, and temporal regions; from the eyelids, and probably also from the nasal fossæ. Their efferent vessels descend to the deep cervical glands. When the superficial and deep parotid glands are the first group to become tuberculous, the primary source of infection will generally be found to be in the middle ear. The anatomical structures of importance which have to be dealt with in removing the parotid lymphatic glands are: the facial nerve, especially its cervico-facial division, the temporo-maxillary (posterior facial) and external jugular veins, and the external carotid artery; the latter can generally be avoided, but the veins, which are more superficial, must be divided.

The *mastoid and suboccipital glands* need not be specially referred to, as they are comparatively rarely tuberculous.

By the term *deep cervical glands* is included a broad chain of lymph nodes which is closely related to the internal jugular vein, and which stretches from the transverse process of the atlas to the root of the neck. The chain is in reality made up of subsidiary glandular groups, each of which receives its lymphatics from fairly well-defined areas. As already mentioned, the different groups are connected to one another by intervening lymphatic vessels.

In the first place, the chain may be divided into an upper and a lower portion, the former situated above the level of the anterior belly of the omo-hyoid muscle, the latter below it. Each of these divisions is again subdivided into an anterior and a posterior chain.

Of the four groups, the *upper anterior* (see Fig. 79, B) is the most important, as it is here that the disease first manifests itself in the vast majority of cases. The reason for this predilection is due to the fact that this group of glands, in addition to receiving efferent lymphatics from the glands of the circular chain, receives also lymphatics directly from the naso-pharynx, including the faucial and pharyngeal tonsils—structures which are now known to provide the chief portals of entrance through which the tubercle bacilli reach the efferent lymphatics. Wood, of Philadelphia, has succeeded in tracing the lymphatics from the tonsils directly into one of the glands of this group, namely, that situated a little below the angle of the jaw, under cover of the anterior border of the sterno-mastoid immediately below the posterior belly of the digastric. The relations of the deep surface of this gland are important. It lies upon the anterior surface of the internal jugular, in the angle between it and the common facial vein. It plays such an important rôle in tuberculous adenitis that Wood has, very properly, suggested that it should be specified as the tonsillar lymphatic gland. In the great majority of cases it is the first gland in the neck to show signs of tuberculous enlargement. With the assistance of Mr. Scott Carmichael, the writer has removed and examined the tonsils in fifty consecutive cases in which this gland was tuberculous. Distinct histological evidence of tubercle was found in seven out of the fifty cases (14%).

When the upper anterior deep cervical glands become enlarged they form a swelling which projects from beneath the sterno-mastoid forwards into the carotid division of the anterior triangle. The mass soon becomes adherent to the general envelope of deep cervical fascia, and if the disease be allowed to run its course the latter becomes perforated, with the result that a subcutaneous tuberculous abscess soon develops. By excising the glands before they become adherent to the fascia, not only are they easily shelled out, but the fascia itself may be preserved and sutured so as to prevent stretching of the cicatrix. The glands are also liable to become adherent to the digastric muscle and to the stylomaxillary ligament; the latter structure separates them from the submaxillary lymphatic glands. The most important adhesions, however, from the operator's point of view, are to the common facial and internal jugular veins.

Below the tonsillar lymphatic gland the infection generally tapers off by the development of a few small tuberculous glands which extend down the antero-external aspect of the internal jugular, as far as where it is crossed by the omo-hyoid muscle. While the majority of these glands are situated outside the carotid sheath, one or two are not infrequently found between the sheath and the wall of the vein. The carotid sheath is not always such a definite structure as the anatomical textbooks would lead us to suppose.

The *upper posterior* group (see Fig. 79, C) of deep cervical glands lies postero-external to the internal jugular upon the origins of the splenius and the levator anguli scapulæ muscles. They are smaller in size than the anterior group, but when enlarged they may form a swelling which projects across the posterior triangle as far as the trapezius. They are embedded in a quantity of fibro-fatty tissue which supports the spinal accessory nerve and the cervical plexus. When these glands are tuberculous the spinal accessory nerve lies either superficial to the mass or more frequently traverses it. Wood has succeeded in demonstrating that the lymphatics from the pharyngeal tonsil, after piercing the posterior wall of the pharynx, pass downwards and outwards behind the sheath of the great vessels to enter the glands situated deeply, just below the tip of the mastoid process. This important anatomical fact serves to explain how it is that these glands are so frequently involved along with the upper anterior group.

In aggravated cases of tuberculous cervical adenitis, the infection spreads downwards as far as the root of the neck so as to involve both lower groups of the chain. The *lower anterior group* (see Fig. 79, D) forms a somewhat narrow chain which is continued down the outer aspect of the internal jugular as far as its junction with the subclavian. Above the level of the omo-hyoid this chain is continuous with the upper anterior jugular group, while below it comes into relation with the superior mediastinal glands. External to the jugular these glands lie upon the scalenus anticus (anterior) and the phrenic nerve. When diseased, the upper as well as the lower internal group of the deep cervical chain dip between the internal jugular and the prevertebral fascia, and when this occurs to an unusual degree the internal jugular vein may be pushed forward so as to occupy a much more superficial position than normal. Although the glands which form this lower internal group receive lymphatics directly from the larynx, trachea, œsophagus, and thyreoid gland, they are much more frequently infected by extension of the disease from the glands above rather than secondarily to the organs above mentioned.

The *lower posterior group* (see Fig. 79, E) of deep cervical glands are continuous above with the upper-posterior group. Like the upper posterior group, they lie altogether behind the internal jugular vein, upon the levator anguli scapulæ, the scalenus medius, and the brachial plexus. The lowest glands of the group, viz. the supraclavicular, are subdivided into a superficial and deep cluster by the omo-hyoid muscle and the middle layer of deep cervical fascia.

GENERAL CONSIDERATIONS IN THE TECHNIQUE

Before describing the technique of the individual operations for the removal of tuberculous cervical glands it may be well to draw attention in the first place to certain general considerations.

The *skin incision* should not be unnecessarily long, but at the same time it should be long enough to give proper access to the disease. Suitable retractors should be freely used; it is therefore an advantage to have a third assistant.

As far as possible the incisions should be made parallel to the natural creases and lines of cleavage of the skin, as the cicatrices which result from them show little or no tendency to stretch, whereas those placed vertically are very liable to do so. If it be necessary to make a vertical incision it should be kept as far back as possible. The deep fascia should not be removed if it can be avoided; by suturing it either independently with catgut, or along with the skin and platysma, it helps to prevent broadening of the cicatrix.

When the glands form a continuous chain or a nodular cluster, *they should be removed as far as possible en masse.* The knife should be carried well down on to the glands, and in dissecting them out it should be kept close to them. When loose connective tissue intervenes between the glands and the surrounding structures, blunt dissection may be employed. This may be carried out either with the finger, with gauze, or by the aid of special instruments, such as Kocher's 'Kropfsonde' and C. H. Mayo's dissecting scissors. The handle of the knife is rather a clumsy instrument for the purpose. If Cheyne's dissector be employed it should be made with the curved end set back so that its extremity is in a line with the handle. When, however, the glands are more or less fixed and adherent they can be removed much more rapidly and safely by clean dissection with a well-sharpened knife, the edge of which should be kept directed towards the glands. The more experienced the operator, the less will he have recourse to blunt dissection. The writer would caution the inexperienced operator against drawing forward the glands and cutting blindly behind them with blunt-pointed scissors; by this procedure either the common facial vein or the internal jugular is very liable to be injured.

The forceps which are used for application to the glands during the dissection should possess toothed extremities. The writer prefers those introduced by Mr. Leedham Green. When it is necessary to make more traction on the glands the operator may use Kocher's toothed artery forceps or one of the various forms of tissue-grip forceps. Fenestrated forceps, specially made for the purpose, are sometimes helpful, but when the glands are caseous they are very liable to be ruptured.

The assistant should *keep the wound as dry as possible* during the course of the operation, as it is important that the operator should see exactly what he is doing. The bleeding is distinctly less under chloroform anæsthesia than under ether, but unfortunately toxic after-effects are much more liable to occur after the use of the former drug. If ether be used the head and shoulders should be elevated so as to prevent venous engorgement. With chloroform, on the other hand, the patient may be kept horizontal, with the field of operation opened out by allowing the head to fall back over a small sand-bag placed behind the neck.

Drainage. The cervical glands cannot be removed without the division of many of the main lymphatic vessels of the neck. Hence a considerable quantity of lymph is mixed with the blood-stained exudate; indeed, it occasionally happens that the former is so abundant as to amount almost to lymphorrhœa. It is advisable, therefore, to leave the drainage tube in position for three days. Except when the wound is in the posterior triangle, it is generally better to bring the tube out through a special opening behind the sterno-mastoid rather than at the main wound, and it is advisable to stitch the tube to the skin rather than to transfix it with a safety-pin—the latter prevents the tube from slipping into the wound, but it does not prevent it from slipping out. The length and direction of the tube should be so arranged that it does not press on the internal jugular vein. Instead of a rubber tube some surgeons prefer to use a cigarette drain of gutta-percha tissue, or several strands of silkworm-gut.

Closure of the wound. The suturing of the wound is a very important part of the operation, especially from the patient's point of view, as the cosmetic result depends a good deal on the care with which it is done. To avoid the scars of the needle-punctures, some surgeons prefer to close the wound by means of a subcuticular suture, but if horsehair (or fine silkworm-gut) be used, and introduced with a fine needle, the cicatrices left by the skin-punctures become practically invisible. The writer prefers interrupted sutures to a continuous one, as the depth of the former can be varied more easily, and, moreover, they allow a certain amount of blood-stained serum to escape between them. The deep fascia may be brought together separately with catgut, or it may be sutured with silkworm-gut along with the skin and platysma. Superficial horsehair sutures are introduced between the main sutures so as to bring about very accurate apposition of the skin edges and prevent their inversion by the platysma. The disadvantage of applying a continuous suture while the edges of the wound are put on the stretch by a hook introduced at each extremity is, that when the hooks are removed the wound shortens, with the result that the stitch is slackened and the skin edges are very liable to become inverted. It is important to see that the head is brought into the natural position while the wound is being closed, otherwise its edges will not fit accurately.

The dressing. In dressing the wound an abundance of sterilized gauze should be used, partly on account of the copious wound exudate, and partly with the object of allowing the bandage to be firmly applied. Moreover, the dressing should extend far beyond the wound in all directions, and the bandage should include the chest as well as the head and neck. When the wound involves, or extends down to, the root of the neck, care should be taken to see that the front and back of the shoulder are well covered.

After-treatment. As regards the after-treatment, it is well to keep the patient recumbent for a few days with head and shoulders slightly elevated. There is often some pain on swallowing for a day or two, and during this time solid food may have to be withheld. As a rule, it is better not to remove the stitches until the seventh day, and after doing so collodion may be applied to prevent the cicatrix from stretching.

EXCISION OF THE ANTERIOR GROUP OF UPPER DEEP CERVICAL GLANDS

This may be regarded as the typical operation for the early stage of disease of the deep cervical glands. The incision (see Fig. 80, B) extends in a line from the tip of the mastoid process either to the hyoid bone or the pomum Adami, depending on the extent to which the disease has extended downwards along the internal jugular vein. The advantage of this incision over one parallel to the anterior border of the sterno-mastoid is that it lies parallel to the natural creases and lines of cleavage of the skin (Kocher); the resulting cicatrix, therefore, shows no tendency to stretch. The more the incision approaches the vertical the greater is its tendency to stretch. The length of the cicatrix should be proportional to the size of the glandular mass. The inexperienced operator generally adds to his difficulties by making the incision too small; it is only the more experienced who should try to reduce the incision to a minimum.

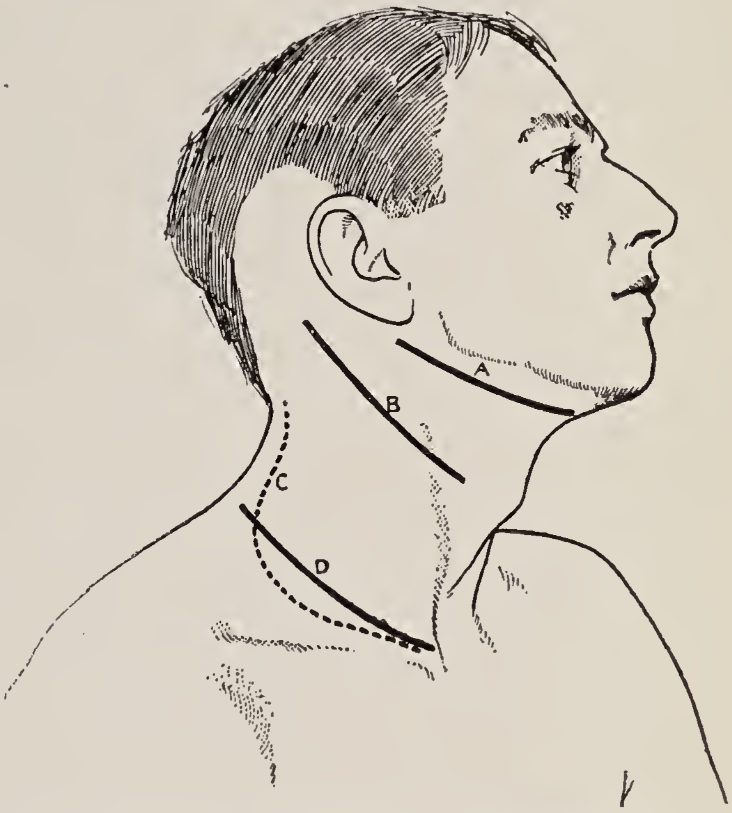

Fig. 80. Incisions for Removal of the Cervical Glands. A, Incision for removal of the submaxillary glands; B, Incision for removal of the anterior group of the upper deep cervical glands; C, Incision when the disease in the lower part of the posterior triangle is very extensive; D, Incision for removal of the glands from the lower part of the posterior triangle in ordinary cases. The incision C or D may be used in conjunction with B when the entire vertical chain of deep cervical glands is involved.

The upper part of the external jugular vein and the great auricular nerve, which lies immediately behind it, are exposed at the upper end of the wound. The former is divided between forceps, and it may be necessary also to divide the nerve. In reflecting the flaps, the operator should keep close to the deep fascia so as to include the platysma and the whole thickness of the superficial fascia. The deep fascia is divided along the anterior border of the sterno-mastoid, and the latter is then freed and dissected backwards off the glands until the spinal accessory nerve is exposed. The nerve is accompanied by the superior sterno-mastoid artery, a branch of which is generally divided before the nerve is actually exposed, so that the operator is warned of its close proximity. The nerve is freed by slitting up the fascia which forms the posterior layer of the sheath of the sterno-mastoid. The superficial aspect of the glandular mass is laid bare by dividing the cervical fascia which roofs over the carotid division of the anterior triangle in front of the sterno-mastoid. The glands are then seized with forceps and drawn forwards so as to facilitate their separation from the deeper sutures. The best way to avoid injury to the common facial and internal jugular veins is to keep the edge of the knife directed towards the glands.

It is a matter of no great importance whether the glands be freed from above downwards or from below upwards. It will generally be found most convenient to begin the deeper part of the dissection at whichever edge of the mass is most accessible, as each structure exposed is a guide to the position of those adjacent to it. When the deep dissection is begun anteriorly, almost the first structure of importance which is encountered is the common facial vein, to which the tonsillar lymphatic gland is generally more or less adherent. At the upper part of the mass is the lower part of the parotid, the deep landmark being the posterior belly of the digastric, immediately below which is the internal jugular vein covered by its sheath. If it be decided to dissect the glands off the jugular from below upwards, the latter should be deliberately exposed below the diseased glands. For this purpose the lower edge of the wound must be well retracted so that the deep cervical fascia may be divided as low down as possible. If the glands be not adherent to the sheath of the internal jugular, their separation is a simple matter. The methods of dealing with the vein when the glands are adherent will be referred to later.

Having freed the glands from the common facial and internal jugular veins, the latter is retracted forwards and the small glands behind and external to it are removed; they are situated deeply on the origins of the splenius and levator anguli scapulæ muscles. To remove them the sterno-mastoid is retracted well backwards and the spinal accessory nerve is hooked aside. These glands, though small, are frequently tuberculous, and failure to remove them is often responsible for recurrence of the disease.

All bleeding having been carefully arrested, a small rubber drainage tube is drawn through a puncture opening made at the posterior margin of the sterno-mastoid opposite the lowest part of the wound. The tube should be directed upwards and inwards from the opening, and care should be taken to see that it does not press on the jugular; its inner extremity should reach to just behind the vein. The suturing and after-treatment of the wound have already been referred to.

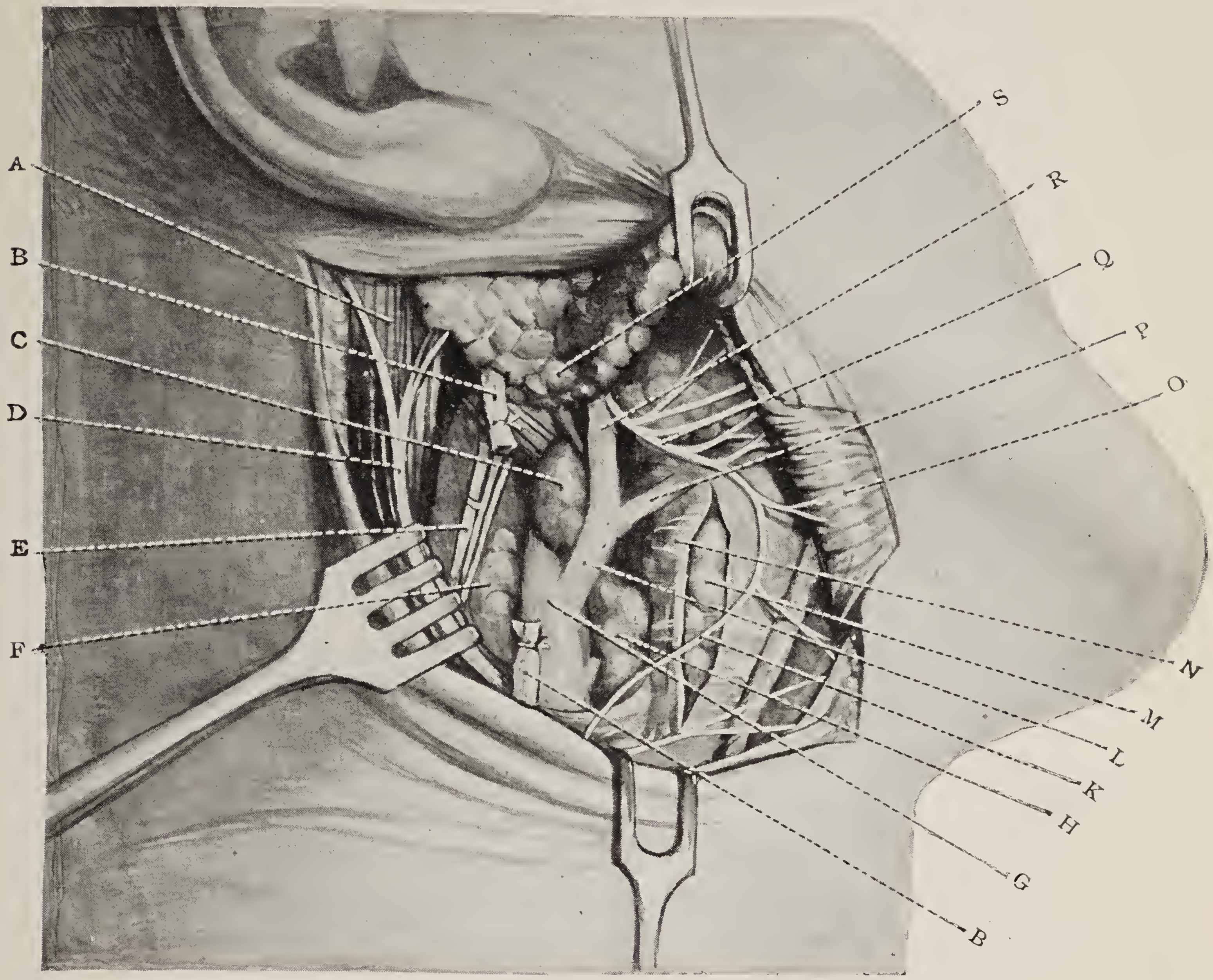

FIG. 81. THE UPPER DEEP CERVICAL GLANDS. Dissection to show the relations of the various anatomical structures met with in excising the upper deep cervical glands by the typical oblique incision extending from the posterior border of the mastoid process to the upper border of the thyreoid cartilage. A portion of the external jugular vein has been resected and the lower part of the parotid gland has been hooked upwards to show the inframandibular branch of the facial nerve; the anterior border of the sterno-mastoid has been retracted so as to expose the spinal accessory nerve and the accompanying superior sterno-mastoid vessels; the tonsillar lymphatic gland is well seen, occupying the angle between the common facial and internal jugular veins; the process of deep cervical fascia has been split to show the submaxillary salivary gland. A, Sterno-mastoid; B, B, External jugular vein; C, Tonsillar lymphatic gland; D, Great auricular nerve; E, Spinal accessory nerve and superior sterno-mastoid vessels; F, Upper posterior deep cervical glands; G, Internal jugular vein; H, Upper anterior deep cervical glands; K, Ramus communicans collo-mandibularis; L, Common facial vein; M, Submaxillary salivary gland; N, Stylo-maxillary ligament; O, Platysma; P, Facial vein; Q, Inframandibular branch of the facial nerve; R, Anterior temporo-maxillary vein; S, Parotid gland.

EXCISION OF BOTH POSTERIOR AND ANTERIOR GROUPS OF UPPER DEEP CERVICAL GLANDS

Here the mass extends backwards into the posterior triangle as well as forwards in front of the sterno-mastoid. By pushing the tumour backwards its outline will be seen to extend upwards as far as the tip of the mastoid process and backwards as far as the trapezius. The lower limit of the tumour generally tails off into a chain of glands which extends for a variable distance under and behind the posterior border of the sterno-mastoid. When the glands are large and softened, the muscle often produces an oblique constriction across the tumour.

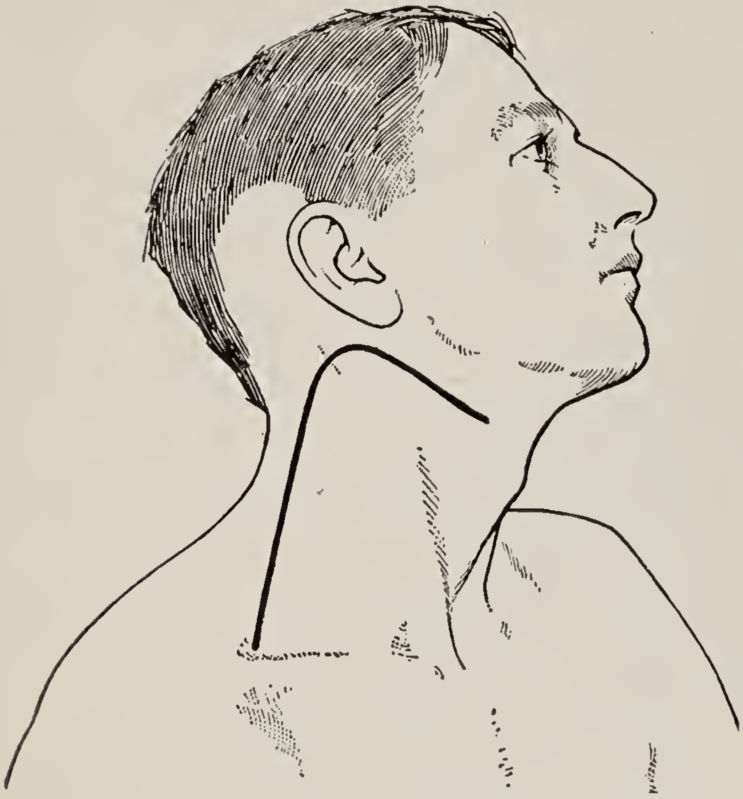

Fig. 82. Incision for Removal of the Entire Chain of Deep Cervical Glands.

The incision which has been recommended above for the removal of the anterior group of glands, even if carried to its full length, does not give sufficient access to the glands which occupy the posterior triangle. A long incision parallel to the sterno-mastoid and midway between its anterior and posterior borders would suffice, but the resulting scar would be conspicuous. A very satisfactory plan of dealing with such a mass of glands is to reflect a flap downwards and forwards off the tumour by means of an inverted J-shaped incision. The upper limb of the incision extends from about opposite the tip of the hyoid bone upwards and backwards to a finger's breadth below the angle of the jaw; thence in a curve directed across the upper part of the sterno-mastoid, behind which it descends vertically for a variable distance, depending on the extent to which the disease has extended downwards. The highest part of the curve reaches to just below the tip of the mastoid process. The descending or vertical limb is generally placed at, or a little in front of, the anterior border of the trapezius (see Fig. 82). The great advantage of this incision is that it gives free access to the glands in both triangles, and that it allows the anatomical structures in the field of operation to be clearly exposed to view. The upper limb of the incision is in the line of cleavage of the skin, and leaves therefore a fine cicatrix in the direction of the natural creases of the neck. The vertical limb is far enough back to be to a large extent hidden from view. The only conspicuous part of the incision is the middle portion which is curved across the upper part of the sterno-mastoid. In cases in which the cosmetic result is a matter of great importance, the middle portion of the incision may be omitted, but in this case the anterior oblique portion of the incision should extend back to the tip of the mastoid process, while the posterior incision should extend up to a little behind the root of the same process. The access is, of course, not so free as it is by the flap incision, but by making the two wounds communicate under the sterno-mastoid, the disease can all be removed.

The steps in the dissection for the removal of the anterior group of glands are the same as above described. In removing the posterior group the posterior border of the sterno-mastoid is freed, after which its deep surface is dissected off the glands and the muscle is retracted well forwards. Before this can be done efficiently, it is generally necessary to divide the posterior fibres of the muscle just below their insertion. While the edge of the muscle is being freed, a careful search is made for the spinal accessory nerve, which becomes superficial about the middle of the posterior border of the muscle. The nerve is much more liable to be injured *after* rather than *before* it has pierced the muscle. When the nerve has been found, it should be freed in both directions so that it may be hooked either upwards or downwards as may be required. Behind the sterno-mastoid it is generally superficial to the glands, while before it pierces the muscle it frequently traverses them. Having freed and retracted the sterno-mastoid and the spinal accessory, the next step is to define the posterior limit of the mass, and then to dissect it from behind forwards off the splenius and levator anguli scapulæ muscles until the posterior aspect of the internal jugular is exposed. In doing this the knife may be carried boldly down to the muscles, as, apart from the spinal accessory nerve, there are no structures to be avoided. Not infrequently the glands will be found to have pushed their way into the septum between the splenius and the levator anguli scapulæ muscles. The superficial branches of the cervical plexus, namely, the small occipital, the great auricular, the transverse and descending superficial cervical nerves, may all be divided if necessary, as they are all purely sensory. The resulting anæsthesia is largely recovered from. The branches from the third and fourth cervical nerves to the trapezius should, if possible, be spared. By completely undermining the sterno-mastoid and retracting it forwards and backwards, the deeper parts of the two dissections are thrown into one.

Whether the flap method or two separate incisions be employed, a single drain is usually sufficient; it should be introduced at the lower part of the vertical wound.

When the disease, in addition to involving both groups of upper deep cervical glands, implicates also the *lower posterior group* as far as the clavicle, the operation is practically the same as above described, with the addition that the supraclavicular glands have to be removed as well. Here, again, either the single J-shaped incision or two separate incisions may be employed; in either case the vertical incision is prolonged down to, or even a little below, the clavicle, which it reaches either at its middle or at the junction of its middle and upper thirds (see Fig. 82).

EXCISION OF THE ENTIRE CHAIN OF DEEP CERVICAL GLANDS

When the disease has advanced so as to involve *all the groups which go to form the deep cervical chain* the tumour-like mass extends from the mandible and mastoid process down to the clavicle. In aggravated cases the mass broadens out at the root of the neck so as to extend inwards behind the lower part of the sterno-mastoid as well as outwards and backwards under cover of the clavicular origin of the trapezius. In a case of this kind the best cosmetic result is got by dissecting out the whole mass through two long oblique incisions. The upper incision extends from an inch behind the tip of the mastoid process obliquely downwards and forwards to the thyreoid cartilage (see Fig. 80, B). The lower incision, which begins at, or a little external to, the middle of the neck, one inch above the suprasternal notch, passes obliquely upwards, outwards, and backwards, to end a little behind the anterior border of the trapezius, about two inches above the clavicle (see Fig. 80, D). In a neck of average length there is usually no great difficulty in throwing the deeper parts of the two dissections into one. In the case of a long neck, however, and when there is no narrowing of the mass at the centre of the neck, the lower incision should be angular. The anterior limb is placed almost horizontally about a finger's breadth above the clavicle; the posterior limb passes upwards parallel to the anterior border of the trapezius as far as its middle, or higher if necessary. The angle between the two limbs is rounded (see Fig. 80, C). By this incision a triangular flap is reflected upwards and forwards off the lower half of the tumour. The dissection through the upper incision has already been described; it should be carried as far down the neck as possible so as to enable the upper mass of glands to be removed down to the level at which the internal jugular is crossed by the anterior belly of the omo-hyoid muscle.

The *lower dissection* must now be described in detail. If the oblique incision be used, the edges of the wound must be undermined so as to enable the flaps to be reflected as far as possible off the glands, the one upwards, the other downwards. In doing this the descending superficial cervical nerves are, of course, divided. Owing to the pressure of the glands on the internal jugular, the lower part of the external jugular vein is often considerably dilated; it must therefore be carefully isolated and divided between two ligatures; these should be applied just before it pierces the cervical fascia at the posterior border of the sterno-mastoid, a little above the clavicle. After reflecting the superficial structures off the lower part of the sterno-mastoid muscle, its posterior border is freed as high up as possible; and in order to reach the anterior limit of the mass it will generally be necessary to divide more or less of the clavicular fibres of the muscle a little above the clavicle. The lower edge of the wound is retracted downwards and backwards so as to expose the clavicle

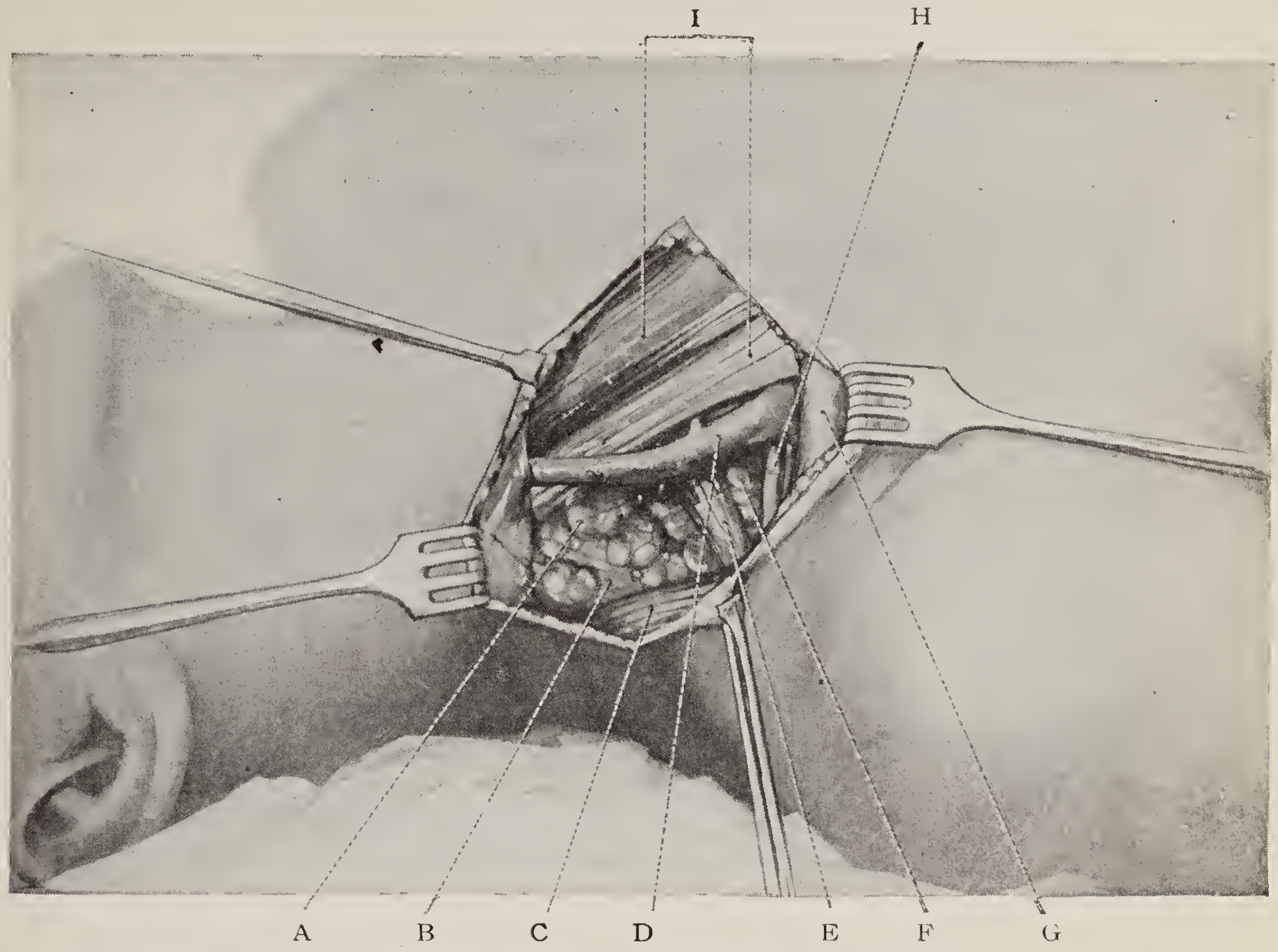

FIG. 83. THE LOWER DEEP CERVICAL GLANDS. Dissection to show the relations of the various anatomical structures met with in excising the lower posterior group of deep cervical glands by the lower oblique incision. The lowest and most superficial glands of this group have been removed to show the deeper structures. A, Lower posterior group of deep cervical glands; B, Levator anguli scapulæ; C, Trapezius; D, External jugular vein; E, Omo-hyoid; F, Supra-clavicular lymphatic glands; G, Clavicle; H, Suprascapular vessels; I, Sterno-mastoid.

and the lower half of the anterior border of the trapezius. In freeing this muscle from the lower and posterior limit of the mass, care should be taken not to injure the spinal accessory nerve; it should be freed in the whole of its course across the posterior triangle, so that it may be retracted out of the way. If the branches of the third and fourth cervical nerves to the trapezius can also be dissected free, so much the better; not infrequently, however, it is impossible to preserve them.

When the lower and posterior angle of the chain extends downwards and backwards for a considerable distance under cover of the clavicular origin of the trapezius, it may be necessary to divide some of its fibres transversely. In dissecting the mass up from the deeper structures it is best to begin from below by dividing the general envelope of deep cervical fascia immediately above the clavicle. When this has been done, the finger or a blunt dissector is passed beneath the lower edge of the mass, which is then dissected upwards off the posterior belly of the omo-hyoid and the middle layer of the cervical fascia. By dividing the fascia the omo-hyoid may be completely freed and retracted out of the way, but when the glands are very adherent it must be removed. The next step consists in retracting the clavicular portion of the trapezius and dissecting out the glandular prolongation which extends downwards and backwards behind the outer third of the clavicle; this can often be done to a large extent with the finger aided by blunt-pointed scissors. The glands are here embedded in a quantity of fatty cellular tissue which contains a plexus of veins large enough to necessitate the application of artery forceps. Posteriorly the glands lie upon the upper digitations of the serratus magnus and the posterior thoracic nerve; the latter lies under the fascia, and is, therefore, protected from injury.

Having got well behind the glands, both inferiorly and posteriorly, the next step is to dissect the chain upwards off the brachial plexus and the scalenus medius. In doing this the transversalis colli artery and vein are divided, but the brachial trunks, including the suprascapular nerve, which springs from the junction of the fifth and sixth cervical nerves, are not likely to be injured, as they are covered by the continuation outwards of the prevertebral layer of deep cervical fascia. The nerve to the rhomboids, and the two roots of the posterior thoracic nerve, lie still deeper, behind the scalenus medius. When the upper wound is nearly reached the glands situated beneath the bridge of soft parts are brought within reach by pushing them downwards with two fingers introduced into the upper wound. The ascending cervical branch of the inferior thyreoid artery is generally divided at this stage of the operation.

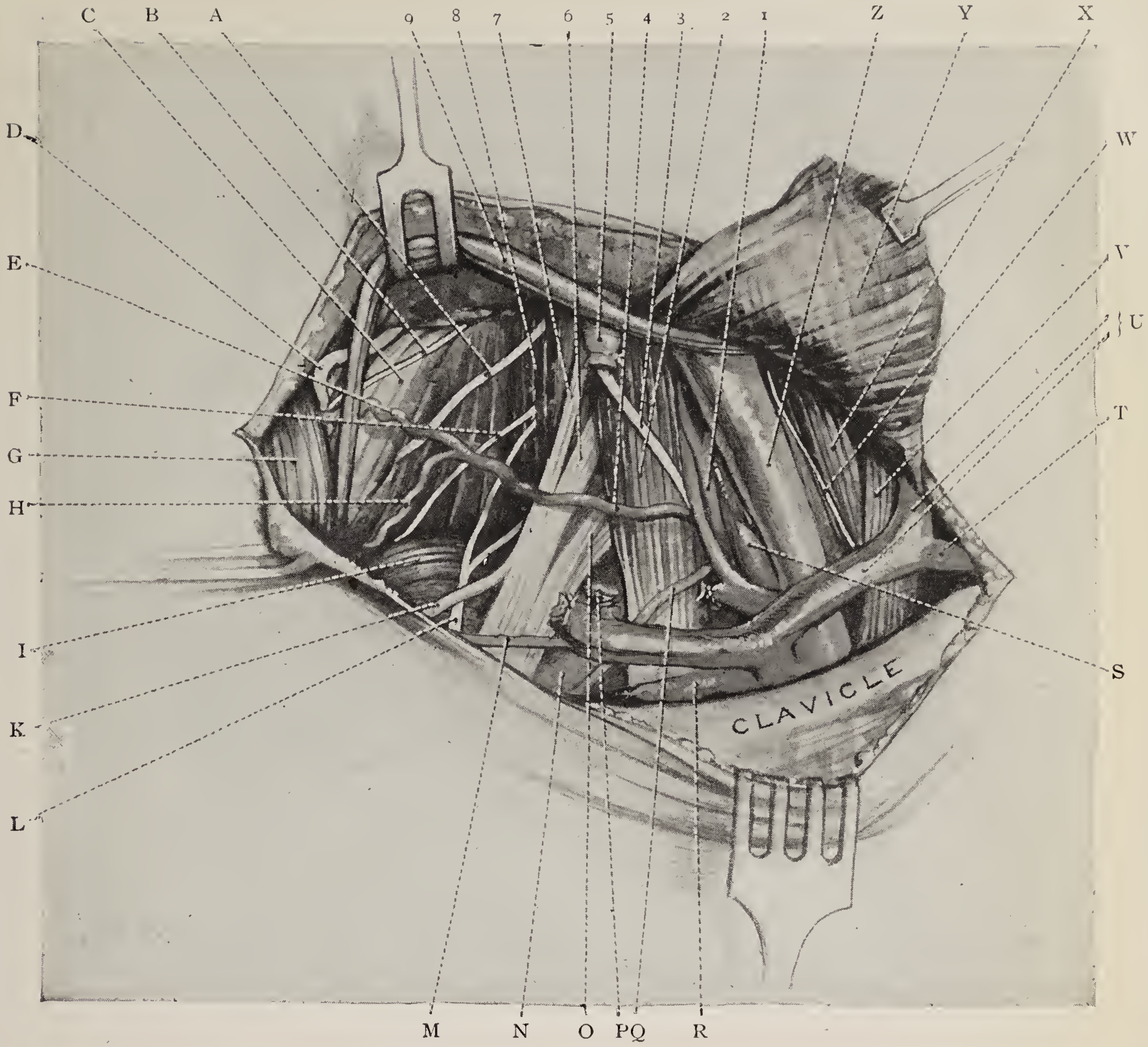

Fig. 84. Further Stage of the Dissection shown in the Previous Figure. To illustrate the relations of the various structures met with in excising the anterior as well as the posterior group of the lower deep cervical glands by an incision extending obliquely backwards and slightly upwards from immediately above the inner end of the clavicle. The clavicular origin of the sterno-mastoid has been divided and thrown upwards, while the omo-hyoid has been freed and retracted upwards; a portion of the external jugular vein has been resected. A, Nerve to the levator anguli scapulæ; B, Branch from the cervical plexus to the trapezius; C, Levator anguli scapulæ; D, Spinal accessory nerve; E, Superficial cervical artery; F, Nerve to the rhomboids; G, Trapezius; H, Posterior scapular artery; I, Serratus magnus; K, Suprascapular nerve; L, Posterior thoracic nerve; M, Suprascapular vein; N, Subclavian artery; O, Seventh cervical nerve; P, External jugular vein ligatured; Q, Suprascapular artery; R, Subclavian vein; S, Vertebral vein; T, Anterior communicating vein; U, Anterior jugular vein; V, Sterno-hyoid; W, Descendens hypoglossi; X, Sterno-thyreoid; Y, Sterno-mastoid; Z, Internal jugular vein; 1, Inferior thyreoid artery; 2, Scalenus anticus; 3, Phrenic nerve; 4, Transversalis colli artery; 5, External jugular vein; 6, Sixth cervical nerve; 7, Fifth cervical nerve; 8, Scalenus medius; 9, Omo-hyoid.

The final stage of the dissection consists in the removal of the lower and anterior group of the chain, the anatomical relations of which are important. In front of these glands are the clavicular portion of the sterno-mastoid, the middle layer of deep cervical fascia, and the outer part of the sterno-hyoid and sterno-thyreoid muscles; posteriorly they rest upon the internal jugular vein, the scalenus anticus, and the phrenic nerve. To gain access to them the posterior border of the sterno-mastoid muscle must be retracted well forwards, and, if necessary, more or less of its clavicular fibres should be divided close to their origin from the clavicle. The anterior belly of the omo-hyoid is freed from the jugular sheath and retracted upwards. After dividing the middle layer of the cervical fascia the glands themselves are exposed. There is usually no difficulty in getting below them, and in dissecting them upwards off the lower part of the internal jugular, the scalenus anticus muscle, and the phrenic nerve. There is no fear of injuring the nerve, as it lies behind the fascia covering the muscle. The fascia is a prolongation outwards of the prevertebral fascia. Not infrequently this chain of glands dips behind the lower part of the internal jugular, and when this is the case, great care should be taken to keep the edge of the knife as close to the glands as possible. Neglect of this precaution may result in a wound of the internal jugular vein, the vagus, or the thoracic duct.

On more than one occasion the writer has found a subsidiary chain of diseased glands lying internal to the scalenus anticus, between the inner edge of the internal jugular vein and the vertebral vein. These glands are important because they lie in close relation to the thoracic duct, which arches outwards behind the lower part of the internal jugular vein between it and the vertebral vein. To remove them, the lower part of the jugular is retracted inwards, while the glands themselves are carefully peeled off the vertebral vein. If possible, blunt dissection should be substituted for the knife, but if this does not suffice, great care should again be taken to keep the edge of the knife directed against the glands. In a case operated on recently by the writer, in which these glands were diseased, the thoracic duct was clearly exposed and avoided. It lies in a quantity of loose cellular tissue, and, being itself very elastic, it is easily pushed aside. Some little trouble may be occasioned by the division of a vein close to its junction with the vertebral vein.

As regards drainage, when two oblique incisions are employed, the upper wound is drained by a tube pulled beneath the sterno-mastoid through a puncture opening made midway between the posterior portions of the upper and lower incisions. The lower wound is drained by a tube placed horizontally across the root of the neck and brought out at a puncture opening a little above the junction of the upper and middle third of the clavicle. If the disease extends far back under cover of the trapezius the opening for the tube may be made still further back through, instead of immediately in front of, the fibres of the trapezius. When the lower incision is angular, the upper wound may be drained by bringing the tube out at the upper extremity of the vertical limb of the lower wound, while the latter is drained by a tube brought out either at the angle of the incision or through a separate opening placed further back. In many cases when the upper wound is large, to make sure of efficient drainage, the writer frequently inserts a very small, almost capillary, drainage tube into the main wound between two of the stitches; the lumen of the tube, although small, is sufficient to allow of the escape of the early serous exudation, while its presence leaves no trace in the cicatrix.

EXCISION OF THE SUBMENTAL GLANDS

When the submental glands are alone diseased they may be removed either through a vertical median incision extending from the symphysis menti to the hyoid bone, or through an incision parallel to and a little below the lower margin of the mandible. Unless the glands form a distinct vertical chain, the latter incision is to be preferred; it leaves a better cicatrix, and if the glands in the anterior part of the digastric triangle are found to be diseased, they can be got at by prolonging the incision outwards. Tributaries of the anterior jugular veins are divided in the superficial fascia. The glands are exposed as soon as the general envelope of deep cervical fascia is split; indeed, they are generally adherent to it. There are no important structures to be avoided, so that the glands may be dissected boldly off the anterior bellies of the digastrics and the intervening portions of the mylo-hyoid muscles. Occasionally the glands are so firmly adherent to one of the digastrics that a portion of the muscle may have to be removed. One or two muscular branches of the submental arteries will probably require to be ligatured.

EXCISION OF THE SUBMAXILLARY GLANDS

To remove the submaxillary group an incision is made from a point about a finger's breadth below the angle of the jaw forwards to a point midway between the symphysis menti and the hyoid bone. Between these two points the incision should curve downwards to the level of the tip of the great cornu of the hyoid bone, so as to avoid dividing the inframaxillary branch of the facial nerve. The posterior extremity of the incision is in front of the external jugular vein, but the anterior jugular is divided at the anterior part of the wound. The glands are exposed as soon as the general envelope of deep cervical fascia is divided. They lie partly below and partly under cover of the mandible. The best plan is to dissect them in the first instance from below upwards off the digastric and stylo-hyoid muscles, and then off the hyoglossus and the posterior part of the mylo-hyoid. The glands are so intimately related to the superficial portion of the submaxillary salivary gland that its removal is generally necessary. The hypoglossal nerve and ranine vein are bound down to the hyoglossus by the fascia which covers it, so that unless the glands are exceptionally adherent there is little danger of injuring them; the vein, however, may be wounded unless the knife be kept close to the glands. In dissecting forwards the posterior glands of the chain from the stylo-maxillary ligament, which separates them from the parotid gland, the anterior trunk of the temporo-maxillary vein is isolated and divided between forceps. When the glands are being separated from the mandible, the facial vessels are generally divided; the vein lies superficial to the submaxillary gland, while the artery is embedded in a groove on its deep surface. In front of the submaxillary salivary gland the lymph glands lie on the mylo-hyoid muscle, and here one or two of them are often hidden away in a pocket under cover of the mandible, to which they may be adherent. In removing them the submental branch of the facial artery is generally divided, but by keeping close to the glands the mylo-hyoid branch of the inferior dental nerve may often be avoided. Anteriorly, the chain is in contact with, and often adherent to, the anterior belly of the digastric muscle. The sublingual salivary gland, the lingual nerve, and the terminal portion of the hypoglossal are all protected from injury by the mylo-hyoid muscle. When the glands which extend up under cover of the angle of the jaw have become firmly adherent to the stylo-glossus muscle and the stylo-maxillary ligament, there may be some difficulty in securing the facial artery and the temporo-maxillary vein. The difficulty may be overcome by prolonging the incision further back so as to free more of the posterior belly of the digastric, which is then well retracted downwards and backwards. The wound may be drained by placing a small tube in the main incision; sometimes, however, it is more convenient to bring the tube out through a special puncture below the incision.

When the infection proceeds from the anterior part of the mouth it is quite common to find the submaxillary glands involved on both sides, in which case both submaxillary triangles should of course be cleared at the same operation.

When the submaxillary glands are involved along with the deep cervical glands on the same side, the J-shaped incision already described for the removal of the deep cervical chain (see Fig. 82) is employed, being modified merely to the extent of carrying the submaxillary limb to a point midway between the symphysis menti and the hyoid bone. By this incision the skin is reflected downwards and forwards off the side of the neck in the form of one large triangular flap. Or a T-shaped incision may be employed, one limb extending along the posterior border of the sterno-mastoid, the other from the junction of the upper and middle third of this incision obliquely upwards and inwards to a little above the middle of the hyoid bone. By this combination of incisions two flaps are dissected off the neck, the one upwards and forwards towards the mandible, the other downwards and forwards towards the middle line. When only the upper part of the deep cervical chain is involved along with the submaxillary group, the disease can be removed through a single oblique incision, extending from a little behind the base of the mastoid process to the hyoid bone. By retracting the lower edge of the wound well downwards, the glands may be removed down to where the internal jugular is crossed by the anterior belly of the omo-hyoid muscle.

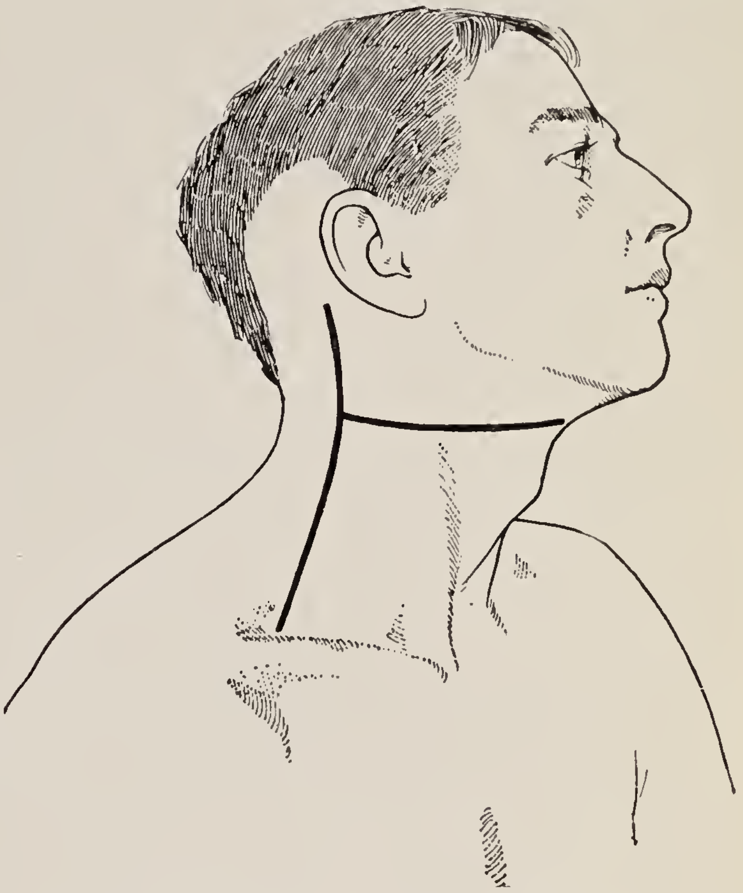

Fig. 85. Incisions for Removal of the Submaxillary together with the Deep Cervical Glands.

OPERATIVE PROCEDURES WHEN THE DISEASE IS COMPLICATED WITH ABSCESSES AND SINUSES

When one or more of the glands of a diseased group have softened and formed a caseous abscess a radical operation should still be performed, and an endeavour should be made to remove all the disease without rupturing or opening into the abscess. Should the abscess be unavoidably opened, all the caseous pus should be squeezed out and wiped away at once, so as to reduce the soiling of the wound to a minimum. In some cases it is an advantage, before proceeding with the dissection, to curette the softened gland, and swab it out with pure carbolic acid. In consequence of the periadenitis which generally results from the suppuration, the gland capsules often become very adherent to the surrounding structures. Fortunately, however, the worst adhesions are generally between the glands and the structures superficial to them, namely, the cervical fascia and the sterno-mastoid. After these have been dealt with there is often comparatively little difficulty in separating the glands from the deeper structures, namely, from the internal jugular vein, from the digastric, and from the muscles forming the floor of the posterior triangle. In cases in which a radical excision seems at first to be almost impossible, with care and perseverance all the disease may often be removed and a clean dissection left. Sometimes, however, the capsule of a deep suppurating gland has become so firmly adherent to the internal jugular that it is impossble to dissect it off. The operator must then either resect a portion of the vein or leave behind the adherent portion of the capsule. The latter plan is generally permissible, provided the portion of the capsule left is well curetted and treated with pure carbolic acid.

When the caseous process has spread through the glands and infiltrated the upper half or so of the sterno-mastoid muscle, the diseased portion must be removed along with the glands. At the close of the operation the divided end of the muscle should be stitched with interrupted catgut sutures either to the levator anguli scapulæ or to the scalenus medius, depending on the amount of muscle removed. In cutting across the muscle it is well to do so obliquely so as to leave the anterior border longer than the posterior; the advantage of this is that a greater extent of the internal jugular vein will be overlapped by the muscle.

Unfortunately, it often happens that the disease is allowed to progress until the caseous abscess into which the gland has become converted has become adherent to, and ruptured through, the general envelope of deep cervical fascia. The perforation of the cervical fascia is soon followed by the development of a subcutaneous abscess. In such a case it is important to operate before the skin itself becomes involved. It is the reverse of good surgery to limit the operation to curetting the abscess in the hope that the glandular mischief which has given rise to it will subside. The result of such a procedure is generally to leave the patient with a persistent sinus. It is this kind of surgery which brings the operative treatment of cervical glands into disrepute. The proper way to deal with such a case is to lay open the abscess freely by whatever incision is best adapted for the removal of the subjacent glands. If the skin over the abscess be already involved, the incision should not be carried through the diseased area of skin, as that only serves to encourage the formation of a tuberculous cicatrix. The better plan is to curve the incision downwards so as to skirt the margin of the involved skin. The flap is then dissected up, and the anterior wall of the abscess is clipped or scraped away from the flap, and some iodoform-bismuth paste is rubbed into the raw surface. The floor of the abscess, which is formed by the deep fascia, is treated in the same way. The opening leading from it into a subjacent gland is investigated, and, if necessary, the sinus and the cavity into which it leads are curetted and swabbed out with pure carbolic acid. The deep fascia is then cautiously divided at whatever part leads most safely to the exposure of the glands, which are dissected out in the usual way. As already stated, the adhesions are less troublesome in the depth of the wound than they are towards the surface. After freeing and retracting the sterno-mastoid muscle, the two most useful landmarks to make for are the posterior belly of the digastric and the internal jugular vein. It is often a good plan to make sure of the whereabouts of the latter by deliberately exposing it in the first instance below the level of the diseased glands. The common facial vein is also a useful guide, but in the cases here referred to the glands are generally so adherent that its division is often unavoidable.

If the skin over the subcutaneous abscesses be so involved by the subjacent tubercle that it is past recovery the incision must be so planned as to excise it. It may be included in either an elliptical or a triangular incision, both of which are made to form part of the main incision for the removal of the diseased glands. If the area of skin removed be not too large, the wound can generally be closed by freely undermining the flaps; if, on the other hand, this cannot be done, the part of the wound which is left open is either stuffed with iodoform gauze or utilized for drainage.

When persistent sinuses are present they are practically always due to the presence of a caseous gland, or glands, under the cervical fascia. Not infrequently the sinus owes its persistence to the remains of a single tuberculous gland capsule. Here, just as in the case of the subcutaneous abscess, it is seldom advisable to limit the operative treatment to scraping the sinus. Such treatment may cause the sinus to heal up for a time, but the cure is seldom permanent. The proper course to adopt is to excise the diseased gland, or glands, along with the sinus. Before commencing the dissection the latter should be scraped and thoroughly disinfected with pure carbolic acid. If more than one sinus exists some ingenuity may be called for in planning the most suitable incisions.

OPERATION FOR RETROPHARYNGEAL ABSCESS

The retropharyngeal abscess of glandular origin lies in front of the prevertebral fascia, whereas that which occurs secondary to spinal caries lies behind it. The glandular abscess originates in one of the lymphatic nodes which lie in the cellular space bounded anteriorly by the fibrous envelope of the pharynx, posteriorly by the prevertebral fascia, and laterally by the lateral pharyngeal fascia, which forms the inner wall of the carotid sheath. There are generally one or two of these glands situated on either side of the middle line, opposite the upper two cervical vertebræ. They receive efferent lymphatic vessels from the nasopharynx. When suppuration occurs in one of these glands the abscess pushes the posterior wall of the pharynx forwards so as to form a distinct fluctuating swelling on one or other side of the middle line. The spinal abscess, on the other hand, generally crosses the middle line. Unless the posterior wall of the pharynx has become so thin that perforation is imminent, the abscess should be opened from the neck. This is a simple enough matter when the upper deep cervical glands are also tuberculous. After these glands have been removed the internal jugular vein is freely exposed, so that to reach the wall of the abscess all that is necessary is to retract the vein forwards and inwards along with the carotid vessels. After the abscess has been opened, its cavity is curetted, care being taken not to perforate the wall of the pharynx. Some sublimated iodoform-bismuth paste is applied to the cavity, which is stuffed with a strip of iodoform gauze, one end of which is brought out at the wound in the neck. If the gauze strip does not give sufficient drainage, a tube may also be introduced.

When, however, the retropharyngeal abscess is the only manifestation of the tuberculous disease in the neck, a careful and definite open dissection must be made to reach it. In the spinal cases the abscess is best reached through an incision made along the posterior border of the sterno-mastoid (see Vol. II, p. 165). In the retropharyngeal glandular abscess, however, the abscess is more easily reached through an incision almost parallel to its anterior border. After splitting the cervical fascia the sterno-mastoid is retracted well backwards, the posterior layer of its sheath is divided, and the spinal accessory nerve is freed and retracted upwards and backwards. The chain of small lymphatic glands which lies posterior to the internal jugular vein is then removed, after which the vein and its sheath are retracted forwards. The posterior belly of the digastric muscle is freed and retracted upwards and forwards. If there be any doubt as to whether the wall of the abscess has been reached, a gag should be placed in the mouth and an assistant should introduce his forefinger and make pressure on the abscess so as to cause it to bulge into the depth of the wound. The abscess is carefully opened either by a small incision or by perforating its wall with sinus forceps (or with a pair of Kocher's artery forceps), the opening being enlarged by separating the blades (Hilton's method). The cavity of the abscess is then treated as above described. The wound is sutured, an opening being left for the gauze strip with which the abscess is lightly stuffed. The dressing is not disturbed until the third or fourth day, when a fresh strip of iodoform gauze is introduced. At the next dressing the stitches and gauze are removed and the opening is allowed to close.

CHAPTER II

COMPLICATIONS OCCURRING DURING OPERATIONS UPON TUBERCULOUS CERVICAL GLANDS: RESULTS

Injuries to veins. When the glands have become adherent considerable difficulty is often experienced in dissecting them off the internal jugular vein. As long as the adhesions are outside the sheath, the latter may be stripped off the vein along with the glands, and this can often be done by blunt dissection. When it is necessary to use the knife, the glands should be seized with toothed forceps and pulled away from the vein, while the edge of the knife, which should be as sharp as possible, cuts cautiously towards the glands. With each touch of the knife, the vein will be seen to fall away from the gland. When, on the other hand, the sheath is firmly adherent to the jugular as well as to the glands, a portion of the vein must be resected. The vein is in the first place isolated and divided between two ligatures below the adherent glands, after which there is generally no difficulty in stripping it and the glands from below upwards off the carotids, the vagus, the sympathetic, and the prevertebral fascia. Some difficulty, however, may be met with in exposing and ligaturing the vein above the adherent glands. To do this the digastric muscle must be freed and retracted well upwards; and if the glands which extend upwards behind it are firmly adherent to it, a portion of the muscle must be removed. When, as is generally the case, the upper ligature has to be applied above the entrance of the common facial vein, the latter must also be ligatured. The advantage of ligaturing the jugular in the first instance *below* the glands is that the vein is more easily followed up when it is distended with blood.

It occasionally happens that the vein is wounded in attempting to dissect very adherent glands off it. The injury may take the form either of a puncture or a small tear. Speaking generally, the best plan is temporarily to close the opening with artery forceps and to defer dealing with it until after the glands have been removed. In cases where there is a possibility of the vein being opened, the digastric muscle should be freed and retracted well upwards so as to provide room for controlling the vein above where it is likely to be wounded. When the hæmorrhage occurs unexpectedly, and the bleeding point is invisible, the wound should at once be firmly plugged. If, on removing the gauze, the opening in the vein be still invisible, or inaccessible, the part of the wound from which the hæmorrhage occurs should again be plugged so as to check the active bleeding while the operator proceeds to remove the glands which obscure the vein. If room can be got to ligature or clamp it above the bleeding point, the main difficulty will have been overcome. The most common place to wound the jugular is where the common facial opens into it. In such a case the latter vein must be ligatured as well, and sometimes also the thyreo-lingual trunk.

It must not be forgotten that the division of a small vein close up to its entrance into the jugular amounts, practically, to a puncture of the latter vein itself. The operator must beware of trusting to a lateral ligature in arresting hæmorrhage from a puncture in either the jugular or the common facial; such a ligature may suffice to arrest the bleeding while the patient is fully anæsthetized, but there is a considerable risk of the ligature becoming detached by the sudden venous engorgement which occurs during vomiting. Twice this accident has happened to the writer; once just after the wound was sutured, and on the second occasion immediately after the patient had been put back to bed. In both cases, fortunately, the complication was successfully dealt with; in the one case by ligaturing the entire vein above and below the puncture, and in the other by suturing it. Unless the opening in the vein is a large one, it is better to deal with it by suturing rather than by double ligaturing the vein. Before applying the sutures the vein is gently clamped above and below the opening so as to allow the forceps which close it to be removed without the occurrence of hæmorrhage. The suture, which should be of fine catgut and continuous, is introduced by means of a fine sewing-needle. After closing the opening in the wall of the vein itself, the edges of the sheath—or any fascial structures in the neighbourhood—should be brought together over it with a second row of sutures.

When a small area of the sheath of the vein has been removed along with an adherent gland, it sometimes happens that the exposed portion of the wall of the vein becomes herniated through the deficiency. When this occurs it is advisable to suture the edges of the sheath over the protrusion.

In dissecting out adherent glands from the parotid, the veins in its substance, viz. the divisions of the temporo-maxillary and the commencement of the external jugular, often bleed rather freely. They are prevented from collapsing by the adhesion of their walls to the somewhat dense stroma of the parotid, and for the same reason it is sometimes difficult to get a sufficient pedicle to prevent the ligature from slipping;

the difficulty may be overcome by carrying the ligature underneath the vein with the assistance of a curved needle.

If the lower part of the external jugular vein be wounded, it should be occluded at once, either with the point of the finger or by the pressure of a gauze swab, otherwise air is liable to be sucked in during inspiration. The pressure must not be removed from the vein until the assistant is ready with his artery forceps to secure the opening. Although the writer has more than once heard air being aspirated into the vein with the characteristic hissing or whistling sound, neither he nor the anæsthetist has observed any untoward effects, either immediate or remote, resulting from it.

Injury to the thoracic duct. Neither at nor subsequent to the operation has the writer become aware that he has ever injured the thoracic duct in excising tuberculous cervical glands. This injury has, however, occurred with sufficient frequency to call for a reference to it. In the *Edinburgh Medical Journal* for October, 1907, Mr. W. J. Stuart, after recording a case of his own, gives a valuable summary of forty-two recorded cases in which the cervical portion of the duct was injured during surgical operations, sixteen of which were for the removal of tuberculous glands; nearly all the rest were for the removal of malignant glands. Death occurred in only five (12.5%) of the cases, so that the injury is by no means so fatal as is often stated. The reason for this is explained by the method in which the duct is connected to the venus system. According to Lower and Tiechmann, the duct frequently opens into the junction of the internal jugular and subclavian veins in a delta-like manner by several channels, or it may subdivide into two or three large terminal branches which enter different veins. When, therefore, only one of the terminal divisions is divided, the others suffice to convey enough chyle into the circulation. ‘Even should complete section occur of a duct which has only a single ending, there is usually a sufficient number of thoracic or abdominal communications with the venous system to prevent that death from inanition which the older surgical writers regarded as the inevitable consequence of division of the great chyle-conducting trunk. These communications are probably in many cases enlarged, owing to pressure upon the duct near its termination by the tumour or enlarged glands for which the operation is performed.’

The accident declares itself at the time of the operation by ‘the sudden flooding of the wound with a fluid which may be almost clear, as the patient has usually had no food for some hours, or clear but mingled with whitish threads, or distinctly milky like skimmed milk or milk mixed with water. Frequently a search reveals the cut end of the duct or a wound in the wall, from which the fluid escapes; and it is interesting to note that this escape is frequently rhythmical, a little jet being expelled at each expiration, showing how important a part the respiratory movements play in the propulsion of chyle through a vessel whose walls are very sparsely supplied with muscular tissue' (Stuart). Should the injury escape notice at the operation it is manifested subsequently either by the subcutaneous collection of a whitish fluid, or by the establishment of a fistula, from which there is often a lymphorrhœa or chylorrhœa sufficiently profuse to soak through the dressing and to produce rapid emaciation and feebleness along with great thirst and hunger.

With regard to treatment, the writer cannot do better than reproduce the following paragraph from Stuart's paper: 'The best treatment, if the wound of the thoracic duct is recognized during the operation, is ligature of the peripheral end; ligature of the central end in addition is in most cases unnecessary, but can do no harm. Suture of a wound in the duct is worth attempting only in very favourable cases. Packing is only justifiable if the surgeon is unable to apply a ligature.

'The best treatment, if the wound of the thoracic duct is not recognized till after the operation, is probably firm packing of the wound, which almost invariably results in cure with or without a comparatively short-lived fistula. Firm supraclavicular external pressure may be successful if the wound is firmly closed, and may also be successful even if the wound is not closed; there have been too few cases of this treatment to allow of a definite expression of opinion upon it. Probably where the accumulation in a closed wound is recognized as being chylous, supraclavicular pressure—the accumulation being left *in situ*—will be a safe and satisfactory method. The wound may be reopened, and a ligature or forceps applied to the duct, usually with complete success; but this is a difficult procedure, and hardly justifiable unless packing has been tried and has failed.'

Nerve lesions. The two motor nerves most commonly injured are the inframandibular branch of the facial and the spinal accessory. Unfortunately it is sometimes impossible to avoid dividing these nerves.

The *inframandibular branch of the facial* pierces the general envelope of deep cervical fascia a little behind the angle of the jaw and then descends under the platysma to join the ascending branch of the transverse superficial cervical nerve. Before supplying branches to the platysma the nerve gives off a branch which passes forwards and upwards to join the supramandibular branch of the facial almost immediately in front of where the facial vessels cross the lower border of the mandible. Jaffé has shown that this anastomotic branch, which he terms the ramus anastomoticus collo-mandibularis, contains the nerve fibres which supply the depressor labii inferioris. The portion of the supramandibular branch of the facial behind the anastomosis contains no fibres which go to the above muscle. Hence, paralysis of the lower lip is caused either by division of the inframandibular branch of the facial before it gives off the anastomotic branch by division of the latter, or by division of the supramandibular branch after it has been joined by the anastomotic branch. Jaffé has further shown that the ramus anastomoticus collo-mandibularis in more than half the cases leaves the inframandibular branch of the facial at, or even a little below, the level of the hyoid bone. In the remaining instances it comes off further backwards nearer the angle of the jaw. The variation, therefore, in the extent to which the fibres which supply the depressor labii inferioris reach below the posterior third of the horizontal ramus of the jaw, accounts for the fact that an incision placed at a given level below the jaw will cause paralysis of the lower lip in one case and not in another. Kocher recommends that the ‘ normal incision ’ for the upper part of the anterior triangle of the neck should extend from the mastoid process to the middle of the hyoid bone, and that it should lie a finger's breadth below and behind the angle of the jaw. As Jaffé rightly points out, when the anastomotic branch to the depressor labii inferioris arises low down, it will be divided by this incision. It is better, therefore, to make the normal incision at a lower level.

In clearing out the submaxillary triangle, the fibres which supply the depressor labii inferioris will escape if the posterior extremity of the incision be kept half an inch in front of the point where the facial vessels cross the lower border of the mandible (Jaffé). To clear out the posterior part of the digastric triangle Jaffé recommends that a second incision be made in a direction from the tip of the mastoid process towards the thyreoid cartilage. In some cases, however, especially when the glands in the parotid compartment of the gastric triangle are very adherent, it is impossible to avoid injuring the inframandibular branch of the facial, with the result that paralysis of the depressor labii inferioris occurs. The paralysis manifests itself by more or less complete immobility of the lower lip on the affected side; it is most noticeable when the patient laughs or attempts to show the teeth. While the paralysis is in some cases permanent, in the majority of instances it is only temporary, and in these cases it is evident that some of the nerve fibres which go to the muscle have escaped injury. The division of the platysma, and of some of the nerve filaments which supply it, no doubt accounts for many of the cases of slight transient paralysis of the lower lip.

The most important lesion following excision of tuberculous cervical glands is undoubtedly that which results from *division of the spinal accessory nerve.* This nerve is subject to considerable variation in size, as well as in the level and depth at which it pierces the sterno-mastoid muscle. As a rule, it passes downwards and backwards in front of the internal jugular vein, but occasionally it passes behind it. The variation in size is due to the fact that the third and fourth cervical nerves often take a larger share than the spinal accessory in supplying the trapezius—indeed, in a few instances the spinal accessory has been found to end in the sterno-mastoid. The nerve is much more liable to be injured in the posterior than in the anterior triangle. In some cases it is impossible to get away all the glands without removing a portion of the nerve. In other cases the nerve is merely divided, in which case the two ends should be united at the close of the operation with a fine silk suture; and to prevent the nerve from becoming embedded in cicatricial tissue, it is well to surround it with a piece of Cargile membrane.

When the trapezius is completely paralysed the shoulder droops, the neck on the same side appears longer, and the inferior angle of the scapula is unduly prominent as well as rotated inwards towards the spine. When the patient shrugs the shoulder the atrophy of the trapezius is shown by the greater prominence of the levator anguli scapulæ on the affected side. The upper extremity hangs somewhat heavily from the shoulder, and fatigue is produced by occupations which entail a sustained support of the weight of the limb. Owing to the fixation of the scapula, movements involving elevation of the limb up to and above the level of the shoulder are performed with greater effort than normal. In many cases, however, it is often remarkable what little functional disability is complained of in cases in which the spinal accessory nerve is known to have been sacrificed. The loss of this nerve is a small price for the patient to pay for getting rid of an extensive mass of disease. When the nerve is divided before it pierces the sterno-mastoid the latter muscle is to a large extent paralysed, as it receives more of its nerve-supply from the spinal accessory than from the second and third cervical nerves. The trapezius, on the other hand, is only partly paralysed if the branches to it from the third and fourth cervical nerves escape injury. When, however, these nerves as well as the spinal accessory have been sacrificed, the trapezius is completely paralysed. The other motor nerves have already been sufficiently referred to.

The only important complications arising from division of the cutaneous branches of the cervical plexus are the neuralgias and radiating pains which sometimes result when the stumps of these nerves are involved in a cicatrix in the region of the posterior border of the sterno-mastoid muscle. In some cases the neuralgia is so severe, and so aggravated by the movements at the shoulder, that the cicatricial tissue must be excised.

RESULTS OF OPERATIONS UPON THE CERVICAL GLANDS

The results of excision of tuberculous cervical glands are most satisfactory. Unless the disease be unusually extensive the mortality is practically nil, and even in extensive cases it is probably not greater than 1%. The writer has had two cases—both very extensive—in which death occurred suddenly within forty-eight hours of the operation. No post-mortem was allowed, and it was not possible to say exactly what the fatal result was due to. In children delayed chloroform poisoning has certainly been responsible for some of the deaths. The ultimate results—provided the operation be sufficiently radical—are equally satisfactory. Among ninety-six patients followed for periods of from three to thirteen and a half years Dowd (*Surgery, Gynecology, and Obstetrics,* March, 1909) found 93.7% of apparent cures: one patient died of phthisis, five had recurrence in the glands, and in all these an ultimate cure was anticipated. According to Dowd 'patients who have passed five years in good health since operation need have little fear of recurrence.' Most surgeons will agree that his statistics 'surely substantiate the statement that the neck is a particularly favourable site for the surgical treatment of tuberculosis and that the operation is one of the most satisfactory of surgical procedures.'

CHAPTER III

OPERATIONS FOR THE REMOVAL OF TUBERCULOUS GLANDS FROM THE AXILLA AND THE GROIN

EXCISION OF THE AXILLARY GLANDS

THE glandular disease in the axilla may occur either alone, or it may be associated with tuberculous cervical adenitis. It is not infrequently secondary to tuberculous disease in the mamma, in which case the latter organ is removed along with the glands. Occasionally it is secondary to tuberculous disease of a rib.

The diseased glands generally form a nodular tumour-like mass which projects towards the base of the axilla and extends upwards under cover of the pectoral muscles towards the clavicle. Not infrequently isolated glands may be felt in addition to the main mass; these often lie in front of the posterior fold of the axilla, in relation to the subscapular vessels. When the subclavicular glands are involved they can often be detected by deep palpation through the infraclavicular triangular depression corresponding to the interval between the adjacent borders of the pectoralis major and deltoid muscles.

Operation. To remove the axillary glands an incision is made along the anterior fold of the axilla. By prolonging its extremities on to the chest-wall and upper arm respectively, the necessary access may be got for removing the disease should it prove to be more extensive than was anticipated. After splitting the axillary fascia the glands are freed from the lower borders of the pectoralis major and minor muscles, and forceps are applied to the long thoracic artery. The posterior flap is dissected back off the glands until the edge of the latissimus dorsi is well exposed. The assistant now retracts the pectoral muscles well upwards and forwards, while the surgeon proceeds to separate the glands from their attachments. In many cases this can be done to a large extent by the finger, by gauze dissection, aided if necessary by the knife, by blunt-pointed scissors, or by a blunt dissector. The operator will generally find it most convenient in the first instance to separate the glands from the serratus magnus by working from before backwards and from below upwards. The intercosto-humeral nerve is divided, but care should be taken not to injure the posterior thoracic nerve, which runs downwards on the muscle rather nearer the posterior than the anterior fold of the axilla. Forceps are applied to the lateral perforating branches of the intercostal vessels. The next step is to follow the glands upwards beneath the pectoral muscles towards the apex of the axilla. When they have been sufficiently freed they are grasped with forceps, and dragged downwards along with the axillary vein, to the sheath of which they are generally adherent. Forceps are applied to the tributaries of the vein before they are divided and, if possible, the division should not be made too close to the main vein, otherwise the ligature is liable to slip. The removal of a portion of the axillary vein is less frequently necessary when the glands are tuberculous than it is when they are carcinomatous.

In removing the glands from the posterior wall of the axilla the subscapular vessels may have to be divided or removed; every attempt, however, should be made to preserve the long subscapular nerve which accompanies them, as it supplies the latissimus dorsi muscle.

When the subclavicular glands are extensively diseased and adherent, further access must be obtained before they can be removed. This can be got either by removing the lower fibres of the pectoralis major, or by partly or completely dividing the muscle as it crosses the axilla, and suturing it again at the close of the operation. The disadvantage of the latter plan is that the limb must be bandaged to the chest during the healing of the wound, otherwise the stitches in the muscle would cut through. It is this fixation of the arm in the adducted position which is largely responsible for the subsequent limitation of abduction.

A better plan than the above, therefore, is to remove the subclavicular glands through a separate incision made a little below and parallel to the middle two-fourths of the clavicle. The cephalic vein, which ascends in the groove between the pectoralis major and deltoid muscles, must be carefully isolated and divided between two ligatures just before it pierces the costo-coracoid membrane. The subclavicular triangular interspace between the two muscles is then freely opened up and their edges well retracted, the pectoralis major downwards and inwards, the deltoid upwards and outwards. If this does not give sufficient room some of the clavicular fibres of the pectoralis major are divided a little below their origin. The pectoralis minor is now exposed, and by dividing the costo-coracoid membrane along its upper border the muscle may be freed and retracted downwards and outwards. To reach the glands the costo-coracoid membrane must be removed and the first part of the axillary vein exposed. In doing this a blunt dissector is used to isolate the thoracic axis artery and vein, which are divided and double ligatured, care being taken to preserve the external anterior thoracic nerve, which supplies the great pectoral muscle. Above, the glands are dissected off the sheath of the subclavius muscle, and, below it, off the upper two ribs and the fascia covering the first intercostal space. Externally, they are carefully separated from the sheath of the first part of the axillary vein, and if they are adherent the sheath must be removed along with them. Lastly, the glands are followed upwards behind the clavicle and the axillary vessels into the root of the neck. In this part of the operation they are dissected off the upper digitations of the serratus magnus and the upper part of the posterior thoracic nerve. When the dissection has been completed the two wounds freely communicate behind the pectoralis minor. Both wounds are closed completely. Drainage is provided for by introducing a tube through a puncture opening a little in front of the posterior fold of the axilla. The tube lies in the gutter between the inner and posterior walls of the axilla.

If the disease be complicated by the presence of an abscess, or a sinus, these conditions are treated on the same lines as has already been described in dealing with tuberculous glands in the neck.

EXCISION OF THE INGUINAL GLANDS

When the disease is confined to the inguinal group an incision is made parallel to and a little below Poupart's ligament, the length of the wound depending on the extent of the disease. When the femoral group is alone involved, the incision should be more or less vertical. When both sets of glands are diseased, a flap with its base at Poupart's ligament is dissected upwards off Scarpa's triangle by means of a horseshoe-shaped incision. When the glands are not adherent their removal is a comparatively simple matter, but when they are caseous and adherent, considerable difficulty may be experienced in separating them from the long saphenous vein and from the femoral vein. In dissecting the glands off the cribriform fascia and the fascia lata, the upper part of the long saphenous vein and portions of the superficial branches of the femoral artery and their companion veins are removed along with the glands. In ligaturing the long saphenous vein close to the femoral care must be taken to see that a sufficient pedicle is left to prevent the ligature from slipping. If the femoral vein itself be wounded the whole vein should not be ligatured; the opening should be sutured with a fine needle and catgut, and the sutured area should be supported by stitching over it the remains of the sheath, or any fascia in its immediate neighbourhood.

If the gland which occupies the crural canal be also diseased, it must be removed by carefully opening up the inner compartment of the femoral sheath, care being taken to keep the femoral vein retracted outwards. If after removing the gland the crural ring seems to be unduly patent, it should be closed according to one or other of the methods adopted in performing the radical cure of a femoral hernia. It is usually sufficient to pass a loop of catgut—or linen thread—through the whole thickness of the pectineus muscle just internal to the femoral vein, and then to pass the two extremities of the sutures from within outwards through the external oblique immediately above Poupart's ligament. By tightening up the suture, and tying the ends together, the crural canal is closed by approximating the inner part of Poupart's ligament to the pectineus muscle.

If the femoral vein has been sutured the bandage should be firmly applied and the foot of the bed should be raised. Should the vein become thrombosed the risk of embolism must be guarded against by preventing the patient from moving the limb.

SECTION III

OPERATIONS UPON THE DUCTLESS GLANDS

PART II

SURGERY OF THE SPLEEN

BY

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CHAPTER I

SURGERY OF THE SPLEEN

The spleen is unique in the number of unsettled questions associated with its normal and pathologic states. It presents problems of most absorbing interest to workers in every field of medicine. The surgeon occupies an important place in clearing up these problems, because many of them center in the extraordinary results which follow the operation of splenectomy in certain diseases, and in the less positive results which follow the operation in other diseases to which the relation of the spleen is as yet only conjectural.

A review of the surgery of the spleen may well include, then, not only a detailed consideration of the operation of splenectomy, but also a summary of the prominent features of the more important diseases related to the spleen, as shown by the effect of splenectomy. Such knowledge is essential to the surgeon if he is to take full advantage of his opportunity to contribute further knowledge, so much to be desired, to the subject of the spleen and its diseases.

SURGICAL ANATOMY OF THE SPLEEN

The relation of the stomach, the pancreas, the diaphragm, and the colon to the spleen must always be considered in splenectomy. The relation of the stomach is most important from a surgical standpoint, because, in every splenectomy, the stomach must be separated from the spleen, and in such separation it may easily be injured, especially when the spleen is large and very adherent. The fundus of the stomach is connected by the gastrosplenic omentum with the gastric aspect of the spleen, and between the layers of this peritoneal fold are found the vasa brevia. These branches of the splenic artery are well named, for their course is extremely short, and, in cases in which the gastrosplenic omentum is still further shortened and obscured by adhesions, the separation of the stomach from the spleen, by dividing the gastrosplenic omentum and securely clamping and ligating the blood vessels in it, must be done with considerable care in order to avoid injuring the gastric wall, or tearing into splenic tissue. The pancreas bears a relation of normal variability to the pedicle of the spleen. The tail of the organ, resting as it does on the posterior aspect of the splenic pedicle, does not usually extend far enough toward the hilus to interfere with placing clamps on the pedicle. In a few instances, however, the tip of the organ is in contact with the hilus, and must be displaced before the pedicle can be ligated. The diaphragm becomes of importance in surgical relationship to the spleen only in cases in which adhesions between spleen and diaphragm develop to a sufficient size to require ligation. The colon in its normal relation to the lower pole of the spleen does not present any difficulties in its separation from the spleen. The small intestines, even in persons with extremely large and adherent spleens, rarely become adherent, and never firmly adherent. The liver is occasionally in apposition to the spleen. More than once I have found it necessary to separate the thinned-out edge of the left lobe of the liver from the superior pole of the spleen, to which it was adherent over a considerable area. The adhesions which develop between the greater and the lesser omentum and the anterior edge of the spleen are also of surgical importance, for they may contain veins of large size and, under such conditions, become a factor in the methodical removal of a large spleen.

The pedicle of the spleen carries the main blood supply to the organ. The splenic artery, the largest branch of the cœliac axis, although it becomes considerably diminished in size after giving off pancreatic branches, the left gastro-epiploic, and the vasa brevia, usually divides into several branches before entering the spleen, so that in splenectomy, especially when the pedicle is ligated in sections, these branches are ligated rather than the main vessel. The returning veins run a more direct course in the fan-shaped pedicle and, uniting into the main splenic vein, return the blood after its course through the spleen, directly to the portal circulation and to the liver. The circulation of the spleen is, therefore, of the greatest physiological interest. The short branches, the vasa brevia, coursing in the gastrosplenic omentum to anastomose with the left gastro-epiploic artery, have already been mentioned.

OPERATIONS ON THE SPLEEN

The advances of modern surgery have tended to limit the operations on the spleen to splenectomy. Splenopexy was advocated in the early days of abdominal surgery as a means of fixing a wandering spleen, but the results were frequently unsatisfactory, and since the safety of removal has been demonstrated and it has been shown that the spleen, so far as can be determined, is nonessential to the adult, and even to the growing child, splenectomy has rightly taken the place of splenopexy. Splenotomy is occasionally employed in localized and accessible abscess, solitary cyst, or hæmatoma, but splenectomy gives more certain results without the protracted convalescence, and is to be preferred if there are no definite contra-indications. Suture and tamponade of splenic lacerations is not, as a rule, a satisfactory method of dealing with injuries to the organ. The records of the surgical management of abdominal injuries during the Great War show that whenever doubt existed as to the advisability of attempting repair to an injury to the spleen, splenectomy proved to be the best procedure. Injuries to the spleen or interference with its blood supply may be sufficient during the course of extensive and difficult resections of the stomach to necessitate its removal. This has occurred on one occasion in the Mayo Clinic. In that instance I spent considerable time repairing superficial lacerations resulting from dislocation of the spleen from the left chest cavity, in a case of chronic diaphragmatic hernia, when it would have been simpler and quite justifiable to have removed the spleen. Splenectomy is usually advisable in laceration, rupture, or perforation of the organ, whether due to gunshot wounds, stabbing, crushing, or indirect violence.

All of the diseases in which splenectomy is indicated because of its curative effect, its power to limit the progress of the disease, or its favorable influence on the course of the disease, are characterized by splenomegaly. Splenic enlargement, however, is also a prominent feature of other diseases, acute and chronic, in which splenectomy does not accomplish these results, and is, therefore, contra-indicated. The differential diagnosis of splenomegaly and an understanding of its surgical indications are consequently matters of first importance.

The age of the patient, the family history, the personal history, the complete blood examination, the resistance of the red blood corpuscles, the Wassermann test, and the character and estimation of the duodenal contents each may provide a clue to the diagnosis, or may even be sufficient to establish one. In the physical examination, it is well to bear in mind the danger of mistaking an enlargement in the upper left quadrant for the spleen. Tumors of the left kidney, cancer of the stomach, ovarian cyst, malignant infiltration of the omentum, pancreatic cyst, or retroperitoneal lipoma may be, and have been diagnosed as enlargements of the spleen. In the presence of a large tumor in the upper left abdomen, the absence of the sharp anterior edge and of the splenic notch, which are so characteristic of the spleen, should arouse doubt that the tumor is the spleen. Fortunately, pyelography and roentgenology make it possible to exclude the kidney and gastro-intestinal tract, and the more recent ingenious method of outlining abdominal tumors and organs by pneumoperitoneum is an important addition to diagnostic technique, although any wide practical value may not be expected or required of it.

The following review of the diseases and conditions associated with splenomegaly is based on our present knowledge of their surgical importance.

Splenic anæmia. The term splenic anæmia is unfortunate, since it has been shown that sooner or later splenomegaly, whatever its cause, will produce a varying degree of anæmia. These two features, splenomegaly and anæmia, in a given case make the term splenic anæmia literally applicable. Its application, therefore, is so wide that conditions which are deserving of special classification are included under the heading "splenic anæmia." A satisfactory classification and nomenclature for this group of diseases is needed. Splenic anæmia, as it is recognized at present, is a disease characterized by chronic splenomegaly, which is the primary manifestation in the course of the disease, a secondary type of anæmia, leukopenia, a tendency to gastro-intestinal hæmorrhages, and in the later stages (stages associated with the name of Banti, who described them in 1894), by cirrhosis of the liver and ascites. The difficulty of distinguishing these later stages of the disease from those terminating primary atrophic cirrhosis of the liver, or a primary thrombophlebitis of the splenic and portal veins, or a syphilitic splenomegaly, has so confused the subject that the justification of recognizing the syndrome described by Banti as an entity is in doubt. It is at least certain, however, that there is a tendency for chronic splenomegaly associated with leukopenic anæmia to progress to this state. The etiology of typical splenic anæmia has not been established. Many facts suggest a chronic infection. It has been asserted that a streptothrix has been isolated, that a diphtheroid organism has been demonstrated, and that repeated injections of *Bacillus coli* into animals produce a condition resembling splenic anæmia. The condition of the spleen at operation and the nature of the adhesions which are so common in such cases, certainly strongly suggest a chronic inflammatory process. The thrombophlebitis of the splenic and portal veins, which is so constantly present in at least the later stages in splenic anæmia, has been considered by some as the causative factor.

Splenic anæmia may occur in children and may conform to the adult type, but more often the blood picture is atypical because of the tendency of the blood of children to revert to a fœtal type of hæmopoiesis, and because of its sensitiveness to toxic agents. A leukocytosis rather than a leukopenia is, therefore, quite likely to be found in splenic anæmia in children. This tendency of the blood in children to respond differently to disturbances of the hæmopoietic system accounts for the confusion in classifying the splenic diseases in early life.

The pathology of the spleen in splenic anæmia although characterized by general fibrosis, thrombophlebitis, and atrophy of the pulp cells, is not sufficiently distinctive to aid in establishing the etiology of the disease, or in explaining the course of the disease.

The indications for removal of the spleen in splenic anæmia are definite, and the results of operation show that only in the terminal stages of the disease should the advisability of splenectomy be questioned. If the disease is recognized in its early stages, and fortunately the large spleen and the blood picture make this possible, splenectomy can be performed with little risk, and with the assurance that the restoration of the blood to normal and the checking of the onward course of the disease will be certain and permanent. When hepatic cirrhosis, indicated by gastro-intestinal hæmorrhages and ascites, has occurred, splenectomy can still be performed without undue risk, and may serve to prevent further changes in the liver, either because toxins heretofore delivered by the spleen are no longer formed, or simply because of the lessened quantity of blood poured into the portal circulation. Several patients at the Mayo Clinic on whom splenectomy was performed in this stage of splenic anæmia have lived a number of years without evidences of recurrence of these signs of damage to the liver. In advanced stages of the disease, splenectomy is associated with much greater risk and difficulties, and the prospects of a real cure are correspondingly lessened, but the results in simply retarding the progress of the disease in a number of patients in this stage show that splenectomy is justifiable, except, of course, in a few whose condition makes the operation obviously unwarranted.

The results of splenectomy in splenic anæmia, as shown in the records of the Mayo Clinic, compiled and studied to September 20, 1920, by H. Z. Giffin, are as follows:

Seventy-one patients with splenic anæmia were operated on. There were nine deaths in the hospital, an operative mortality of 12.6 per cent. The operative mortality for patients in the early stages of the disease was approximately 8 per cent; for patients in the late stages, 20 per cent. There have been twenty-two subsequent deaths, at an average of two years and five months after the operation, but the majority of these patients were operated on in later stages of the disease, and death apparently was the result of the changes in the liver and portal circulation which had already been set up, as indicated by the fact that fourteen patients reported gastro-intestinal hæmorrhages. The remaining twenty-eight patients, concerning whom information was received, are in good or fairly good condition. Twenty-seven patients in the series had been operated on more than five years before, and of these, seventeen lived more than five years; sixteen are still living; one, who at the time of operation, nearly twelve years ago, was suffering from ascites, severe anæmia, and apparantly marked hepatic cirrhosis, is now in good health.

In children the results are excellent. In 1915, I removed the spleen from a child of thirty months for splenic anæmia with hæmorrhages. This child was in good health and had a normal blood picture at the time of the last report in 1916.

Although the causal factor of splenic anæmia is unknown (and this is one of the cardinal points in the disease), there are other conditions which are characterized by splenomegaly and anæmia, which are either due to known specific organisms, or have other characteristics which serve to distinguish them from splenic anæmia. The more important conditions in this group, excluding tropical splenomegalies and malarial spleen, are syphilitic splenomegaly, tuberculosis of the spleen, Gaucher's disease, and septic splenomegaly.

Syphilitic splenomegaly. The predominant features of syphilitic splenomegaly are chronic splenomegaly, a secondary type of anæmia without leukopenia, and a positive Wassermann reaction with other evidences of syphilis. The patients who have been studied in the Mayo Clinic and have come to operation have not evidenced a tendency to develop the liver changes which accompany typical splenic anæmia, but it is quite possible that similar changes would occur if the splenomegaly and anæmia continued over many years. Gummas in the liver and small gummas in the spleen are occasionally demonstrated, and usually Treponemas may be found in the spleen. Intensive treatment for syphilis has not effected any favorable results on the splenomegaly, the anæmia, or the Wassermann reaction in these cases; but the removal of the spleen not only restores the blood picture to normal, but makes possible effectiveness of treatment for syphilis, as shown in the negative Wassermann reaction. We have removed the spleen in ten cases of syphilitic splenomegaly, with excellent results in six cases. There was one hospital death and two subsequent deaths in the group. A number of patients have been treated with excellent results without removal of the spleen.

Tuberculosis of the spleen. A tuberculous infection of the spleen with splenomegaly primary, in the sense that active tuberculous foci are not demonstrable elsewhere in the body, may occur. Under such circumstances, splenectomy is indicated. Features characteristic of splenic tuberculosis have not yet been established. Polycythæmia has been reported, but it is not a constant finding. In one patient from whom I removed a very large spleen, which proved to be tuberculous, the condition was not suspected before operation. The spleen was enveloped in a mass of adhesions which formed almost a complete capsule for the organ, a condition probably associated with attacks of pain and soreness over the spleen which had occurred during the development of the splenic enlargement, and probably residual to a tuberculous peritonitis. Eight cases of tuberculosis of the spleen, in which splenectomy seemed advisable, have been observed in the Mayo Clinic. One patient died in the hospital and one died later. The remaining patients are in good health with great improvement

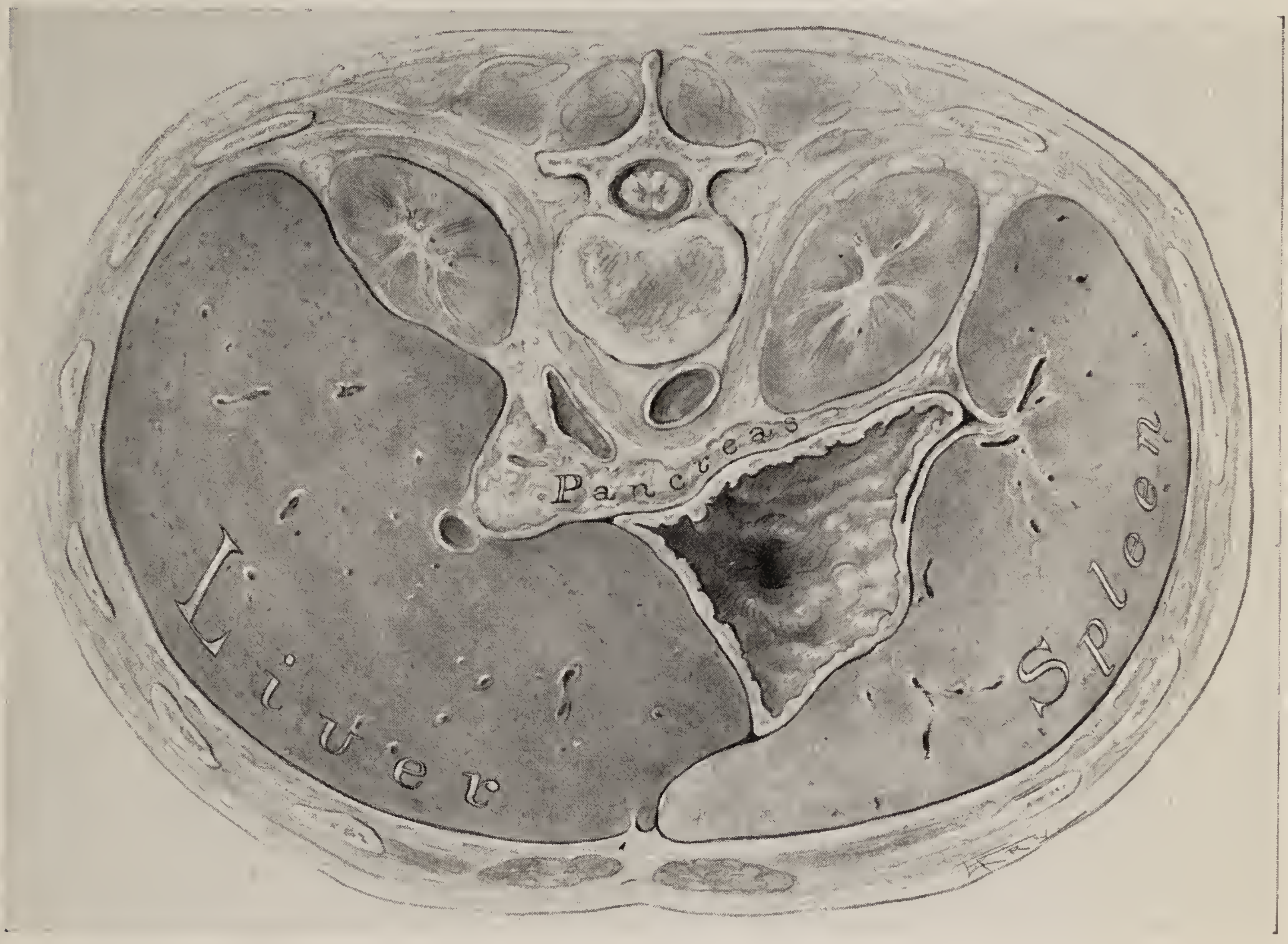

Fig. 86. Transverse Section of the Abdomen at the Level of the Epiploic Foramen, Diagrammatically Representing the Relations of a Large Spleen.

in the blood picture, which had shown marked anæmia before operation.

Gaucher's disease. A diagnosis of Gaucher's disease cannot be made with certainty before operation. The blood picture simulates splenic anæmia, and mucosal hæmorrhages may occur. One point of diagnostic significance is the extreme chronicity of the splenomegaly. The average time the enlarged spleen has been present in the reported cases is twenty years; the onset usually occurs in childhood. Various observers have shown that the endothelial proliferation, which is characteristic of the disease, is not confined to the spleen, liver, and lymph glands, but can be found in the blood vessels and in the bone marrow. This finding has raised the theoretic doubt as to the permanent efficacy of splenectomy, but there are enough well authenticated cases of permanent results in the literature to show the doubt to be unfounded. In the Mayo Clinic six patients with Gaucher's disease have been operated on and good health ensued in two cases, for as long as twelve years in one.

Chronic infectious splenomegaly. A group of cases which may simulate splenic anæmia because of the chronic splenomegaly and secondary anæmia sometimes with leukopenia, may be conveniently grouped under the term "chronic infectious splenomegaly" since they are characterized by recurrent attacks of sepsis. In twenty-five cases classified under this heading, operation has been performed in the Mayo Clinic. The operative mortality has not only been high in the group (28 per cent), but a number of the remaining patients died within seven months of operation with cardiac or renal disease. Splenectomy, then, for splenomegaly and anæmia associated with chronic recurrent sepsis, such as localized phlebitis, chronic tonsilitis, arthritis, nephritis, furunculosis and ulcerative endocarditis, is of high risk and of doubtful value.

Hæmolytic jaundice. Hæmolytic jaundice is probably the most satisfactory term to apply to a group of diseases in which destruction of the erythrocytes is so increased that jaundice of varying degree results. The pathogenesis of the disease is obscure, and the custom of continental observers of recognizing various atypical forms of the disease as separate clinical entities, has added confusion to this phase of the subject. Whatever may be the correct classification of the various forms of the disease, it is most important that the surgeon is familiar with its more common clinical manifestations, and realize that splenectomy is a certain, prompt, and permanent therapeutic remedy.

Hæmolytic jaundice may be congenital, familial (usually also congenital), and acquired. From a clinical standpoint, the chief difference in these forms is the degree of severity of symptoms. There are wide differences between a mild familial type, in which the patient may go through life without any other manifestation than a slight icteric tinge, and the acquired form, in which disabling crises occur and serious complications develop.

The symptoms of a typical case of hæmolytic jaundice are characteristic. Jaundice is the most obvious feature of the disease. It is chronic and of the acholuric type; that is, bile is absent from the urine (although it may occasionally be demonstrated during a crisis), but it is always present in the blood. Urobilin is present in the urine. The jaundice, being of the acholuric type, is not associated with the complications which accompany jaundice due to common duct obstruction, namely, itching of the skin, petechiæ, clay stools, and bradycardia. The splenomegaly is sometimes extreme, and the organ is probably always enlarged, even in the mildest form of the disease, although some cases have been recorded in which it could not be palpated. The blood picture usually shows anæmia. Krumbhaar, in a study of collected cases, showed that the red blood cells varied between 510,000 and 5,700,000; the average count was considerably lower in the acquired cases than in the congenital and familial cases. The anæmia may simulate pernicious anæmia, and Chauffard believes that there is an icteric form of pernicious anæmia which, when accompanied by diminished erythrocytic resistance and reticulated red cells, represents the least compensated form of hæmolytic icterus. This type of case, possessing features of both hæmolytic icterus and of pernicious anæmia, is of great surgical interest and will be referred to later.

Hæmolytic jaundice, especially of the acquired type, is characterized by the so-called crises, during which deepening of the jaundice, increase in the size of the spleen with local soreness, and signs of general intoxication, malaise, headache, fever, and rapid pulse occur. In one case I unfortunately removed the spleen from a patient who had just recovered from a severe crisis of this type, and death occurred thirty-six hours after the operation, due to an overwhelming toxæmia.

The most important contribution to our knowledge of hæmolytic jaundice is that of Chauffard, who showed that the fragility of the red blood corpuscles is constantly increased in the disease. The increased hæmolysis which is the cardinal feature of the disease may be estimated by measuring the quantities of urobilin and urobilinogen in the extracted duodenal contents. This method also gives a very satisfactory indication of the severity of the disease.

The most common surgical complication of hæmolytic jaundice is cholecystitis, which is frequently associated with stones. The calculi are usually of the pure, bilirubin calcium type.

Splenectomy produces its most spectacular results in hæmolytic jaundice. I have removed the spleen from a boy of nine who was jaundiced from birth. The jaundice began to fade within a few days after operation, and completely disappeared in three weeks, for the first time in the child's life. While operation is clearly indicated in typical cases with definite crises, there is a difference of opinion with regard to the removal of the spleen in very mild cases. If the spleen is large and hæmolysis is marked, even though crises have not occurred, it is better to remove the organ because of the very positive results of splenectomy, because of its safety, and because of the ineffectiveness of other therapeutic measures. Elliott and Kanavel, who were the first in America to make a comprehensive presentation of the subject of hæmolytic jaundice, in 1915, tabulated forty-eight cases with two deaths. Not only is the operative mortality the lowest in any group of splenic diseases, but the immediate and late results are most satisfactory. In the Mayo Clinic sixty-nine patients with hæmolytic jaundice have been splenectomized with four deaths, an operative mortality of 5.8 per cent. Two of the deaths it is difficult to ascribe to the operation. The sixty-five patients were cured and have remained well. Gall-stones were present in 68 per cent, even in the young patients.

Cirrhosis of the liver. The fact that Rolleston and others speak of a cirrhosis of the liver due to poisons delivered from the spleen, the marked similarity between Hanot's cirrhosis and hæmolytic jaundice as pointed out by W. J. Mayo, the effectiveness of splenectomy in splenic anæmia associated with moderately advanced cirrhosis and ascites, and numerous other clinical and pathologic observations point to the intimate relation between the spleen and the liver. The possible role of the spleen in hepatic cirrhosis should be kept under continued investigation. The results in thirty-four cases (portal cirrhosis nineteen cases, biliary cirrhosis fifteen cases), upon which splenectomy was performed in the Mayo Clinic, show not only a high operative mortality (25 per cent) but a high subsequent death rate; these were all advanced cases, however. It is still uncertain what splenectomy may accomplish in early cases.

Another interesting problem concerns the relation of the spleen to gastro-intestinal hæmorrhages of obscure origin. When repeated gastro-intestinal hæmorrhages threaten life, and when there is no evidence on which to base a diagnosis of the underlying condition, a surgical search for the cause of the hæmorrhage is usually ill advised, because it is usually futile. As an example, I removed a spleen about twice normal size (not palpable before operation) from a patient in whom several operations on the stomach and on the gall-bladder had failed to find the cause of repeated and long continued gastro-intestinal hæmorrhages, which had almost cost him his life. It is now five years since the splenectomy and there have been no further hæmorrhages.

Thrombophlebitis of the splenic and portal veins has been described as a clinical entity, and splenectomy has been reported when the condition was so marked as to lead to the belief that it constituted the primary and underlying cause of the whole pathologic picture. The condition so frequently accompanies splenic anæmia (it has already been mentioned as a possible cause of splenic anæmia) that it seems more reasonable to assume that it is only one factor in a more extensive pathologic condition, as, for example, an associated lesion of splenic anæmia.

Pernicious anæmia. The blood picture in splenic anæmia indicates faulty blood formation, in hæmolytic jaundice increased blood destruction, and in pernicious anæmia both faulty formation and increased destruction. To those who had witnessed the excellent results of splenectomy in splenic anæmia and hæmolytic jaundice, it was natural that the question of the possible value of splenectomy in pernicious anæmia should have arisen. It was obvious, of course, that the operation would be valueless in advanced stages of the disease, but it was by no means certain what could be accomplished in the early stages. The immediate results of splenectomy in the latter group were sufficiently encouraging to cause a large number of splenectomies to be carried out in selected cases of pernicious anæmia. It is now possible fairly to estimate the real effect of the removal of the spleen on this disease, and thereby, at least provisionally, to establish the indications for removal. Giffin, in a study of fifty-three cases, classified as pernicious anæmia, in which the spleen had been removed in the Mayo Clinic, found that the results of operation were as follows:

There were three hospital deaths in the series, an operative mortality of 5.6 per cent. Forty-three of the patients subsequently died; the majority, so far as could be determined, died from the pernicious anæmia. The important fact, however, is that of the entire series of patients eleven (20 per cent) lived from three to four years after operation, and five others (10 per cent) lived for from four to five years after operation.

This experience with the surgical treatment of pernicious anæmia in the Mayo Clinic justifies certain conclusions at the present time: Splenectomy has no place in the later stages of the disease when the bone marrow and other hæmopoietic structures are permanently and seriously disabled, for it cannot promise more than the transient improvement incident to bone marrow stimulation. In cases before such changes have occurred, splenectomy insures remissions two and one-half times as long as the average remissions which characterize the uninterrupted progress of the disease. The real value of splenectomy then, in the earliest stages of the disease, that is, before the characteristic blood changes have occurred, will not be known until we can recognize the early signs of pernicious anæmia as such. Finally, it may be suspected that those cases in which an apparent cure has been reported, were not cases of true pernicious anæmia, and should be tabulated with some other group of the hæmolytic anæmias, or their classification deferred.

Splenomyelogenous leukæmia. Although little hope can be entertained that splenectomy will have any permanent influence in this disease, the forty-two cases in which operation has been performed in the Mayo Clinic show definitely two facts: The repeated statement that splenectomy is a prohibitive operative risk is a myth, for there were only three deaths in the series, a mortality of 7.14 per cent, and in chronic cases with relatively low leukocyte counts long remissions of good health may follow splenectomy. In the series of twenty-six cases, for example, one patient lived almost five and one-half years after splenectomy, seven lived more than three years, and six of these are still alive. The removal of the spleen, after the leukocytes and the spleen have been reduced as much as possible by the use of radium, cannot be disregarded as a possible beneficent procedure.

Lymphocytic splenomegaly. Six cases characterized by an extreme degree of lymphocytic hyperplasia have been classified by Giffin under this heading. The pathologic distinction between malignant processes and malign processes is difficult in this group. One of the patients died one year after operation with a history of metastatic extension, another eight years later with probable malignancy of the liver. The remaining four, however, are in good condition, one thirteen years, two more than two years, and one six months after operation.

Lymphosarcoma. In four cases the spleen was removed for lymphosarcoma, with rather surprising results. There were no deaths, although the spleens were huge, and the patients lived for considerable lengths of time after operation. One patient, a young married woman with one child, lived nearly eight years afterward, raised two children, and died from lymphosarcoma which had metastasized to the lungs.

Purpura. The results of splenectomy for purpura have been most gratifying. Since Kaznelson showed that removal of the spleen leads to symptomatic cure of this disease many reports confirming this observation have been made.

The splenomegaly occurring in purpura may be classified with the chronic septic infections, in which the diagnostic features are purpuric spots, positive tourniquet test, low platelet count, markedly prolonged bleeding time, delayed retractility of clot but usually normal coagulation time of the venous blood. The tourniquet test consists in applying the arm band of the blood-pressure instrument at a pressure impeding the venous return, but not preventing the entrance of blood, usually at about 100 mm. for three to five minutes. If the result is positive, small petechiæ will appear on the skin of the arm.

We have removed the spleen in eighteen cases of typical thrombocytopenic purpura, with no operative mortality. The condition of some of the patients before operation was extremely poor, but by repeated transfusions of blood it was improved sufficiently to justify splenectomy. Recovery in each instance was rapid. In seventy-two hours the platelet count jumped from below 80,000, in several cases below 40,000, to normal or above. The increase in platelets was not maintained in all cases. Several of the patients before dismissal had blood platelet counts of less than 200,000, but these patients have all remained well.

Polycythemia vera. In polycythemia vera, or Vaquez-Osler's disease, the outstanding clinical features are the intense bluish-red or intense red of the skin, especially of the face, and mucous membranes, particularly of the lips and tongue; certain patients appear almost cyanotic. They often have headache and sometimes high blood pressure. The spleen varies greatly in size, and occasionally it is not palpable. It never reaches the enormous size seen in cases of myelogenous leukemia, or Gaucher's disease. The most important laboratory finding is the increased number of erythrocytes, varying from 5,500,000 to 10,000,000, or, as in a case observed in the Mayo Clinic, to 14,000,000. The hemoglobin, by the acid-hematin method of estimation, is increased; the readings by the Dare method, however, are often very inaccurate. The blood viscosity is practically always increased, as is the total blood volume, in some cases to more than twice the normal.

Naturally, the cell percentage of the total blood volume is increased sometimes much above the normal of 43 to 45 per cent by hematocrit. In one case of polycythemia vera the spleen was removed apparently in the terminal stages. Although the spleen was unusually large there was a remarkable restoration of health which has lasted for more than four and a half years.

Other conditions for which the spleen is occasionally removed are: chronic malaria, kala-azar, tumors, cysts, and injury.

TECHNIQUE OF SPLENECTOMY

The difficulties of splenectomy vary between wide limits. In a relatively small, nonadherent spleen, the removal of the organ is extremely easy and safe, if a technique is employed which protects the stomach and pancreas from injury and securely controls the vessels in the pedicle and in the gastrosplenic omentum. In cases of long standing splenomegaly, however, with the spleen fixed by extensive firm adhesions containing large vessels, a thickened shortened pedicle, and the patient in poor condition, the operation may be extremely difficult and hazardous, and may tax not only the experience, but also the skill of any surgeon. It will, therefore, be more pertinent to describe in detail the technique for removing spleens of this type.

The abdomen is explored through a midline incision, beginning at the ensiform, and continuing downward for a distance commensurate with the size of the spleen. Increasing experience has led to the adoption in the Mayo Clinic of a midline incision as recommended by Percy, because it permits easier access to the points at which the spleen is normally or abnormally attached, and permits complicating pathologic conditions, such as of the gall-bladder or appendix, to be dealt with, if advisable, at the time of splenectomy. The suggestive frequency with which jaundice, attacks of epigastric pain simulating biliary colic, cirrhosis, and gall-stones occur in many of the diseases for which splenectomy is advocated, necessitates an accurate record of the condition of the liver, gall-bladder, and bile-passages. Such observations should ultimately have considerable value in adding further facts to the relationship between the spleen and the liver.

It will be found most advantageous to deal with all accessible adhesions before any attempt is made to mobilize the spleen. For example, in the late stages of splenic anæmia, all adhesions to the anterior border of the spleen, which may be not only extensive, but also contain large venous trunks, should be divided between ligatures. This should be done with extreme gentleness, because any rough handling of the adhesions is not only liable to tear the friable veins, but is likely to tear the spleen, and engage the attention of the surgeon unnecessarily, as well as obscure the operative field. After careful division and ligation of all accessible adhesions, the spleen may be dislocated from its position against the diaphragm and the left kidney. The separation of the diaphragmatic adhesions can usually be safely accomplished by the fingers. If it appears that these diaphragmatic adhesions are of sufficient size to require ligation, it is even then preferable, in most cases, to defer such ligation until the spleen has been removed, the bleeding being temporarily controlled by a gauze

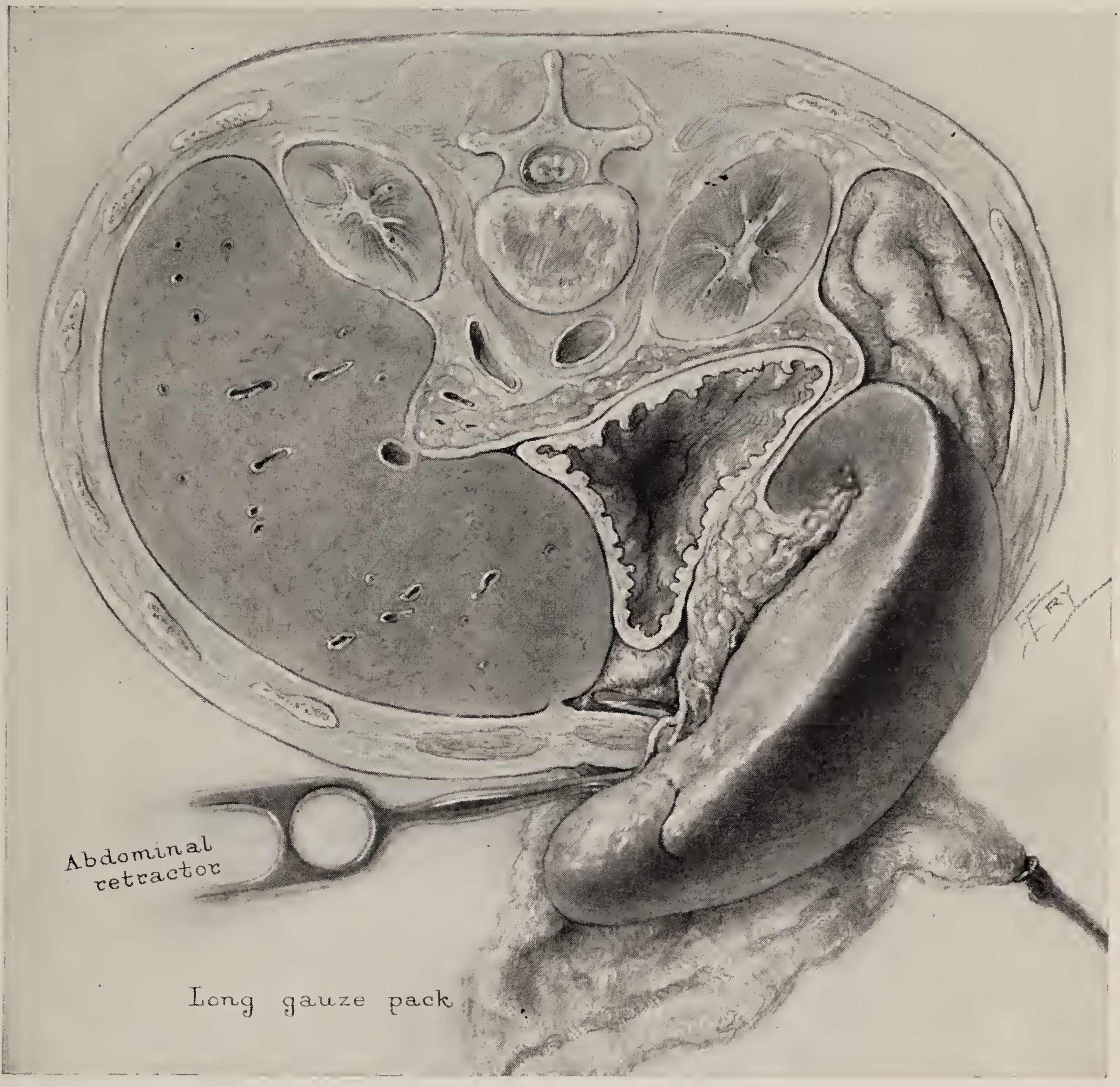

Fig. 87. Relations of a Large Spleen after Its Partial Mobilization and after Introduction of a Long Gauze Pack into the Diaphragmatic Space.

pack. In an occasional case, however, these diaphramatic adhesions cannot be stripped with safety, and they must be divided between long curved forceps, care being taken to engage only the adhesions in the clamps.

Immediately the spleen has been dislocated, a long, hot gauze pack is efficiently arranged in the space formerly occupied by the spleen, until the entire diaphragmatic and renal areas with which the organ has been in apposition, are under firm pressure from the gauze (Fig. 87). This pack serves a valuable purpose in compressing the oozing surfaces, for the bleeding is venous, and it is usually controlled without subsequent ligation, if the pack is left undisturbed until the actual operation is completed; the pack also provides excellent support for the safe manipulation and mobilization of the organ, and the division of further adhesions and the ligation of the main pedicle.

When the spleen has been elevated in this manner (Fig. 87), its further connections, other than those already divided, are the main splenic pedicle with its peritoneal investment (the lienorenal ligament), the gastrosplenic omentum, and, in splenomegaly of long standing, adventitious adhesions. The most satisfactory isolation and treatment of the splenic pedicle is obtained by the preliminary division of these further adhesions, as well as of the peritoneal attachments and reflections. The gastrosplenic omentum should first be divided in sections, between ligatures, as close as possible to the spleen. The only named vessels encountered in this peritoneal fold are the vasa brevia, which arise from the splenic artery at variable points, pass to the greater curvature of the stomach, and finally anastomose with the left gastro-epiploic. In dealing with the upper edge of this gastro-splenic omentum, it must be remembered that here the fundus of the stomach is normally in very close apposition to the spleen. It is necessary, therefore, always to determine the exact relationship and protect the stomach from injury in its separation from the spleen. A number of surgeons have recorded operative injury to the stomach. In my early experience I accidentally included in a clamp and excised a small area of the wall of the stomach; the resultant opening, however, was readily closed without post-operative complications. At the lower pole of the spleen there is an occasional fibrous attachment, derived from the phrenocolic ligament, which, with the other adhesions, should be ligated separately.

Having separated the spleen from these attachments, further mobilization of the organ may be carried out. At this point, in advanced cases of splenic anæmia and obstructed portal circulation, as the spleen is being separated by the fingers from its adherent position against the lienorenal ligament and the peritoneum covering the kidney, large veins engorged with blood, coursing in the thickened lienorenal ligament, may be torn, and furious hæmorrhage encountered. The whole cavity in which the spleen formerly lay becomes suddenly filled with blood. It is then that the advantage of having completed all the steps in the operation with the exception of the actual control of the splenic pedicle is manifest, for the only way to gain access to these torn veins is by removal of the spleen. This can be accomplished rapidly by the two-clamp method (Fig. 88); the field which is filled with blood is mopped out and the torn veins are located. Fortunately, the veins are very easily controlled by pressure, so that the surgeon can maintain pressure over the site of the bleeding with an ordinary abdominal gauze pad in his left hand and, with the

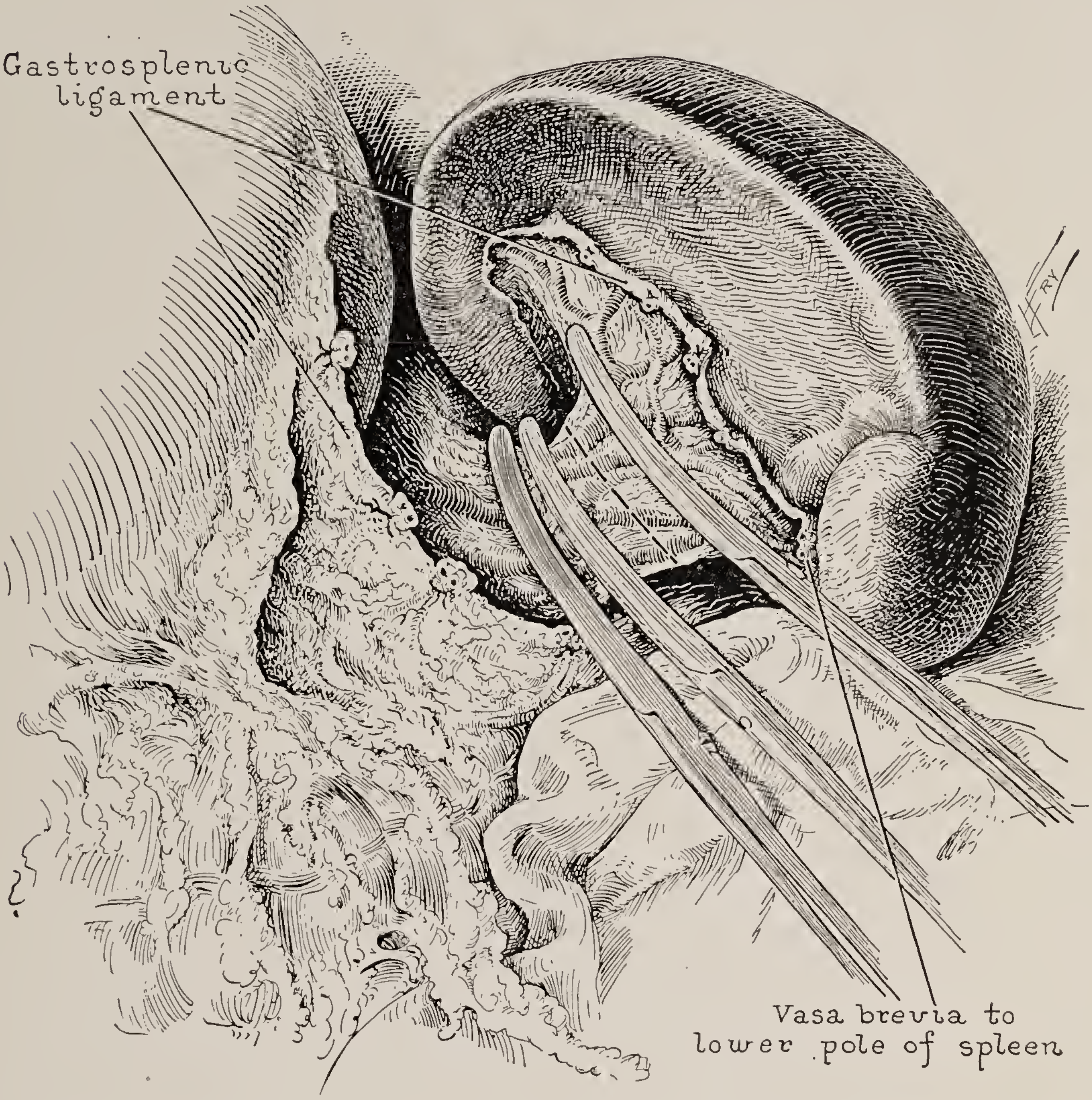

Fig. 88. The Peritoneal Attachments Separated, so as to Permit the Application of Clamps. The splenic pedicle is to be divided at the dotted line.

aid of his assistant, mop up the blood which has collected in the splenic space, until he can be assured that the only source of bleeding is under the pressure of his hand. These veins can then be easily tied. Such a complication is, of course, the exception from the rule.

In the ordinary case, when all accessible adhesions have been divided and the splenic pedicle exposed anteriorly, the spleen may be drawn toward the middle line, and a deliberate ligation and division of the pedicle be undertaken from its posterior aspect, a method of approach which I prefer. The spleen, which in many cases, at this stage of the operation, lies outside the abdomen, may be mobilized even further by careful dissection of the peritoneal and fibrous coverings of the splenic pedicle. The localization of the tail of the pancreas is an important feature of this dissection, for its relationship is not constant, and the tip may extend into the operative field, so that it is necessary to be certain that the pedicle can be clamped without including the tip of the gland. In some instances the tail lies against the renal surface of the spleen, on the posterior aspect of the pedicle, and is fitted so closely into the hilus of the spleen as to have acquired a concave edge. In other cases the tail is attenuated, it is in

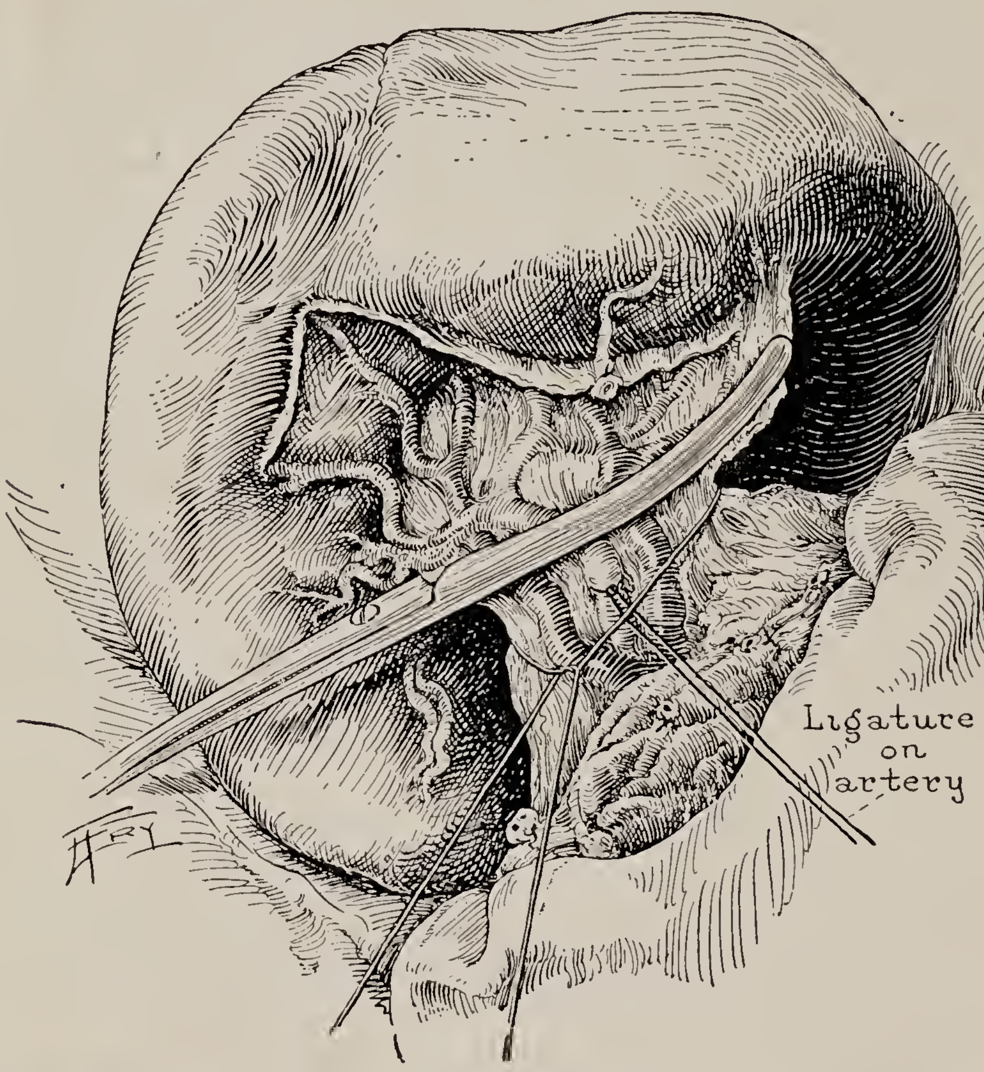

Fig. 89. Ligation of the Splenic Pedicle en Masse.

front of the splenic vessels, and in contact with the gastric surface. More often it does not extend into the operative field.

Figure 89 shows that with the reflection of the lienophrenic ligament a clear exposure of the tail of the pancreas is obtained, and that it can then be easily detached from its original position by dissection and allowed to drop back from the hilus of the spleen.

After such dissection the splenic pedicle consists, from a surgical standpoint, of the splenic artery and its veins. Quite frequently accessory spleens may be seen in the pedicle. These should be removed. Lymph nodes are rarely seen. Krause has recently pointed out that the amount of extravisceral lymphoid tissue appears to be in inverse ratio to the amount of intravisceral lymphoid tissue. The artery in some instances divides before reaching the hilus of the spleen, although it often continues as a single trunk well into the hilus. The veins are always in two or more branches, and are always distinctly larger than the artery itself, and are often extremely friable. The arrangement of the vessels of the pedicle is fan-shaped (Fig. 90), the breadth varying in different cases.

At this point it is possible to decide whether it is best to ligate the pedicle *en masse* (Fig. 89), or in sections (Fig. 90). The latter method is to be preferred, and as I have stated, the dissection of the pedicle is usually most advantageously carried out on its posterior aspect, with the spleen drawn toward the middle line. The extent to which the spleen can be lifted out of the abdomen by careful traction is surprising, if, following the division of the peritoneal and fibrous investments of the pedicle, certain of the lateral venous trunks are separately isolated and divided between ligatures (Fig. 90). It should be emphasized again that caution must be exercised in the degree of traction to which some pedicles are subjected, because of the possibility of tearing friable veins. It is chiefly because of the normal tortuosity of the splenic artery that this elongation of the pedicle, which facilitates its secure ligation, is possible. We have recognized the advisability of first placing a ligature on the splenic artery (Fig. 90) when it can be easily accomplished, so that the spleen may partially empty itself of blood through the unclamped veins before the latter are ligated.

If, because of a very short, thick pedicle and poor exposure, or because of the arrangement of the veins and arterial branches, ligation in sections is not advisable, ligation of the entire pedicle by the two-clamp method, after Mayo, will prove a satisfactory and safe procedure. Two curved clamps are arranged on the pedicle, with a third clamp on the splenic side to control "back bleeding," and the spleen is removed. As a partial control, a double strand of No. 2 plain catgut is tied with moderate tension in the crushed line of the inner clamp, and as the actual control, a second strand is transfixed below the distal forceps.

Having made certain by either of these methods, that the pedicle is securely ligated (it is a good practice to place double ligatures on all vessels in the pedicle) the large hæmostatic pack is removed, and the newly exposed surfaces are inspected, any oozing points being either separately secured by ligation or caught in a continuous catgut suture, which brings together the loose folds in the diaphragmatic renal space with sufficient pressure to control the oozing veins. It will be found much easier and more efficient to introduce the needle on the diaphragmatic side during relaxation of the diaphragm. Absolute hæmostasis can be obtained practically always by such methods, and drainage or tamponage is not necessary.

SUMMARY

The general operative mortality rate in 443 cases in which splenectomy was performed at the Mayo Clinic has been 10.15 per cent. The rate in the different diseases has varied from 2.9 per cent in hæmolytic jaundice to 25 per cent in hepatic cirrhosis.

The disease or condition for which splenectomy is performed governs to a considerable extent the technical difficulties and risk of operation. For example, in pernicious anæmia, the removal of the spleen can be accomplished with comparative ease and safety. Although the organ has been enlarged in the cases in which we have advocated surgical treatment, adhesions were few and usually insignificant. The pedicle is small, as a rule, and can be ligated without difficulty. The slight risk of the operation in this disease can be further lessened by intelligent pre-operative treatment and observation, as well as by the careful selection of cases. Repeated transfusions of blood will frequently carry the patient through most critical exacerbations of the disease, and make splenectomy a safe procedure, should it be indicated. It is important also that a known satisfactory donor be available after operation.

In cases of splenic anæmia, splenectomy is associated with a higher operative risk and greater technical difficulties than it is in any of the more common diseases of the spleen. The spleen is usually large, the vessels very friable, and adhesions occasionally troublesome, and the patients, particularly in the late stages of the disease, are in bad condition, with fever, ascites, cirrhotic liver, and severe anæmia from

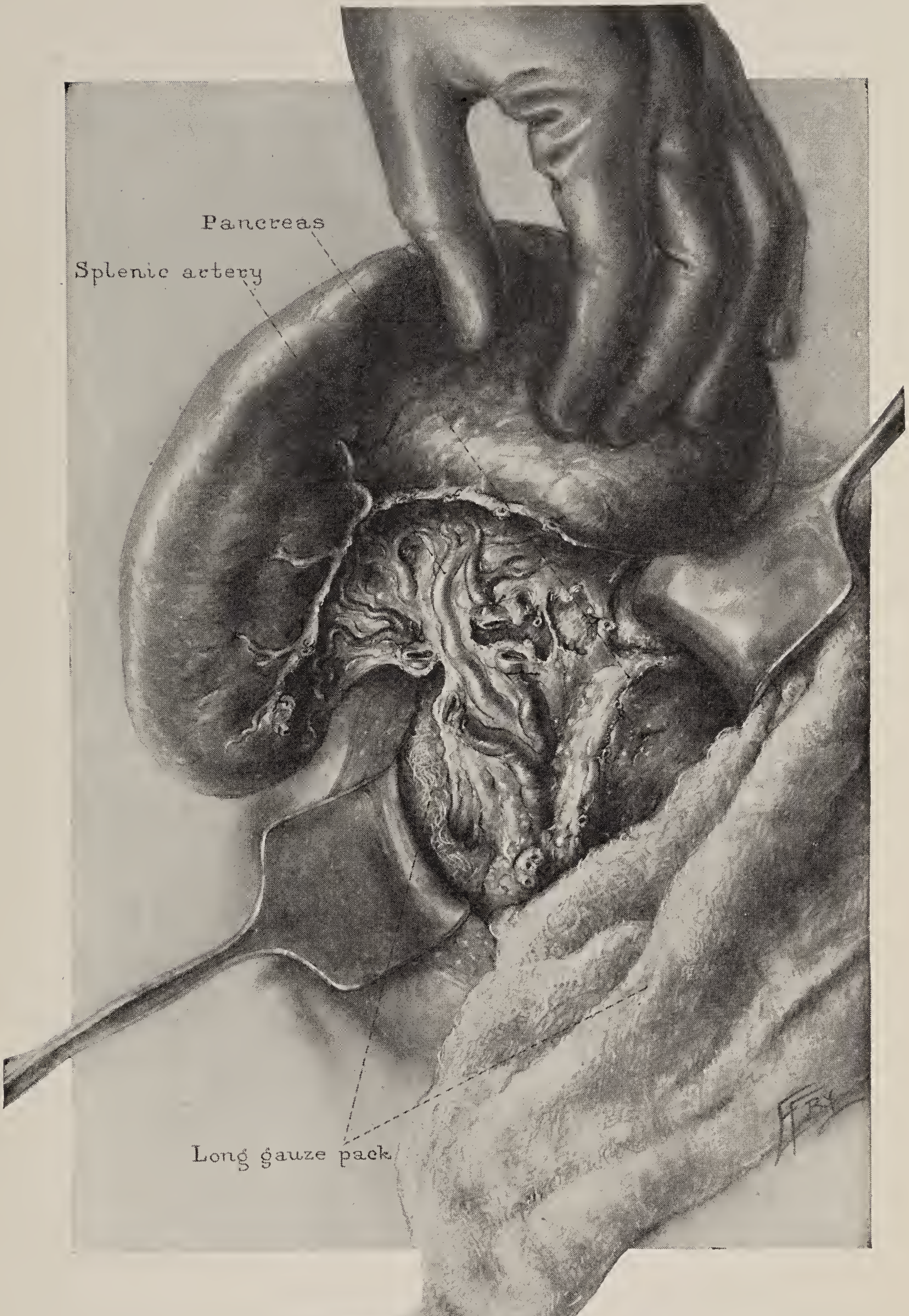

FIG. 90. LIGATION OF THE SPLENIC PEDICLE IN SECTIONS (from the posterior side).

repeated hæmorrhages. The seriousness of the operation, under such circumstances, may be considerably decreased by preliminary transfusions. Occasionally transfusion is required following the operation, either immediately, or subsequently during convalescence.

The operation in cases of hæmolytic jaundice is of relatively little risk; we have met with no particular difficulty in the removal of the spleen, although the organ is occasionally very large. It is most important, however, to avoid splenectomy during an exacerbation of the symptoms. The only operative death in the series in the Mayo Clinic occurred in a patient in whom I failed to realize the import of a subacute and subsiding acholuric crisis.

In those cases of cirrhosis of the liver, associated with splenomegaly, in which splenectomy is to be considered, the spleen is often firmly adherent, and this fact, together with the poor general condition of the patient, makes the operation very hazardous, and, as has been pointed out, of doubtful benefit.

Septic splenomegaly has been associated with a mortality rate of 20 per cent in the Clinic.

In conditions such as syphilitic spleen, tuberculosis, and splenomyelogenous leukæmia (after the spleen has been reduced in size by radiation), splenectomy does not carry a risk of more than 5 per cent.

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SECTION III

OPERATIONS UPON THE DUCTLESS GLANDS

PART III

OPERATIONS UPON THE THYROID GLAND

BY

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SURGICAL AFFECTIONS OF THE THYROGLOSSAL DUCT

BY

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CHAPTER I

OPERATIONS ON THE THYROID

The technique for the removal of the thyroid gland varies but little for different types of goiter—colloid, adenoma, carcinoma, or exophthalmic. We shall, therefore, consider in this discussion principally the technique employed in the multiple stage operation for exophthalmic goiter. In severe cases of exophthalmic goiter or of that slightly differentiated type of goiter called toxic adenoma, the patient must be safeguarded by every possible measure. It follows that a technique whereby the thyroid gland can be safely removed from an extreme case of exophthalmic goiter may be modified with any type of goiter according to the needs of the patient.

Since the safety of the patient with exophthalmic goiter is the unit of measure for operation upon any patient with goiter of whatever type, the diagnosis of exophthalmic goiter and the determination of the operability of the individual become matters of prime importance.

Diagnosis. As this paper deals primarily with technique, methods of diagnosis will not be described, excepting to note that, in general, differentiation between a typical case of exophthalmic goiter and other types of goiter presents no difficulty. A patient with thyroid enlargement, rapid pulse, nervousness, tremor, an increased metabolic rate, emaciation, and exophthalmos presents a syndrome seen in no other condition. One of the most characteristic signs of exophthalmic goiter, which is present in about 99 out of 100 cases, is a palpable superior thyroid artery. In borderline cases, a positive reaction to the Goetsch test and an increased metabolic rate help to define the diagnosis. In particular, increased appetite with loss of weight is strong evidence of exophthalmic goiter.

Operability. According to the type of goiter and the condition of the individual patient, the type of operation is determined—whether it shall be a single or a multiple stage operation; if the former, whether it shall be performed without removing the patient from his bed, or in the operating room; if the latter, whether ligation on both sides can be done at one time, to be followed later by a complete thyroidectomy in one séance; or whether both the ligations and the thyroidectomy should be performed in several stages. It should be borne in mind, moreover, that no pre-operative decision is final; but that, as will be emphasized later, the progress of the various stages is to be determined during the operation by the reaction of the patient.

In general, in the case of a simple colloid goiter, of an adenoma, or of a mild case of exophthalmic goiter, the operation is performed in the operating room in one séance, provided there is no evidence of failing myocardium, and unless the patient is of advanced age. In cases with a slight loss in weight, and slight tremor, but with a stable myocardium, the thyroidectomy is performed in one séance, but in the patient's room, without removing him from his bed. If there is a marked bruit or thrill over the thyroid arteries, associated with loss of weight, marked tremor, and rapid pulse, ligation always precedes the thyroidectomy, the number of stages being determined by the degree of severity of the symptoms and by the reaction of the patient to the operation itself. In other words, every case is individualized.

In our experience, it has been necessary to divide the thyroidectomy into two stages in only one out of one hundred cases. In 99 cases out of 100, we resect both lobes at one séance after the preliminary ligations. In the presence of a weakened myocardium one or more pre-operative courses of digitalis are given—tincture of digitalis in 30 minim doses every four hours for 12 doses. No operative procedure is considered until the maximum operability for the individual patient has been reached. In considering the advisability of operating in the patient's room, special precautions to avoid infection are essential. By completely encircling the operative field with sterile equipment, including sterile bedsheets, operating sheet, towels, etc., it is possible to control the wound in operations in the patient's room as effectively as when the operation is performed in the operating room.

The anæsthetic. All operations on the thyroid are performed under nitrous oxide-oxygen analgesia and local anæsthesia. The anæsthesia is not allowed to pass beyond the stage of analgesia excepting momentarily, as the need of the patient may demand. In fact, the patient himself practically directs the anaesthetist, who keeps in touch with him throughout the operation by questioning him. If the patient shows any signs of discomfort, the anæsthesia is deepened slightly for a moment. The following conversation between a patient and the anæsthetist during a thyroidectomy is typical:

Patient: "I am not asleep. I know everything."

Anæsthetist: "Yes, of course you do; you look quite happy about it."

Patient: "Am I getting oxygen?"

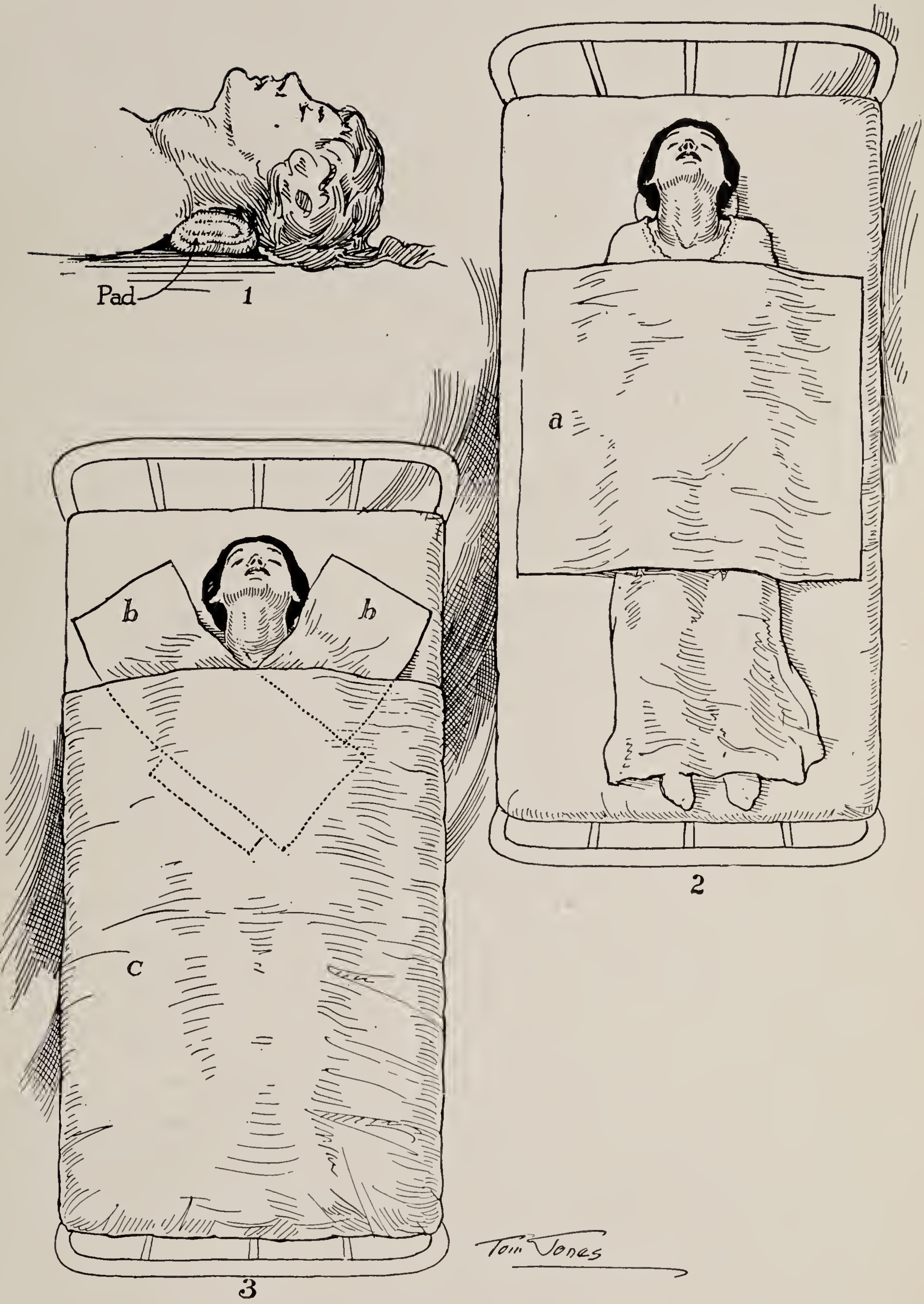

Fig. 91. Preparation of Patient for Operation in Room.

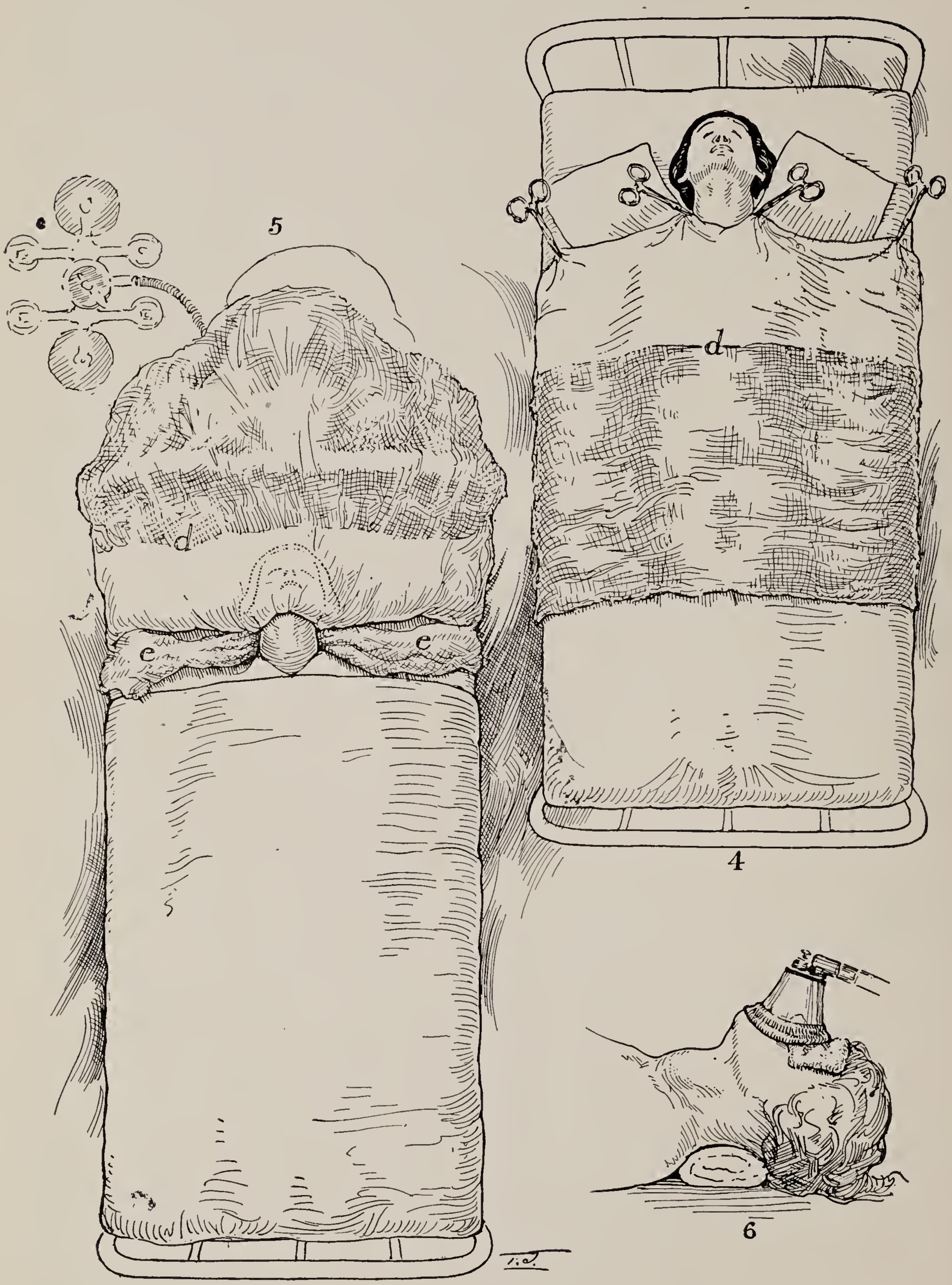

Fig. 92. Preparation of Patient for Operation in Room. Arrangement of sterile linen.

Anæsthetist: "Yes, you are getting it all the time; it makes you feel fine, doesn't it? Now I want you to keep quiet for a while and not talk."

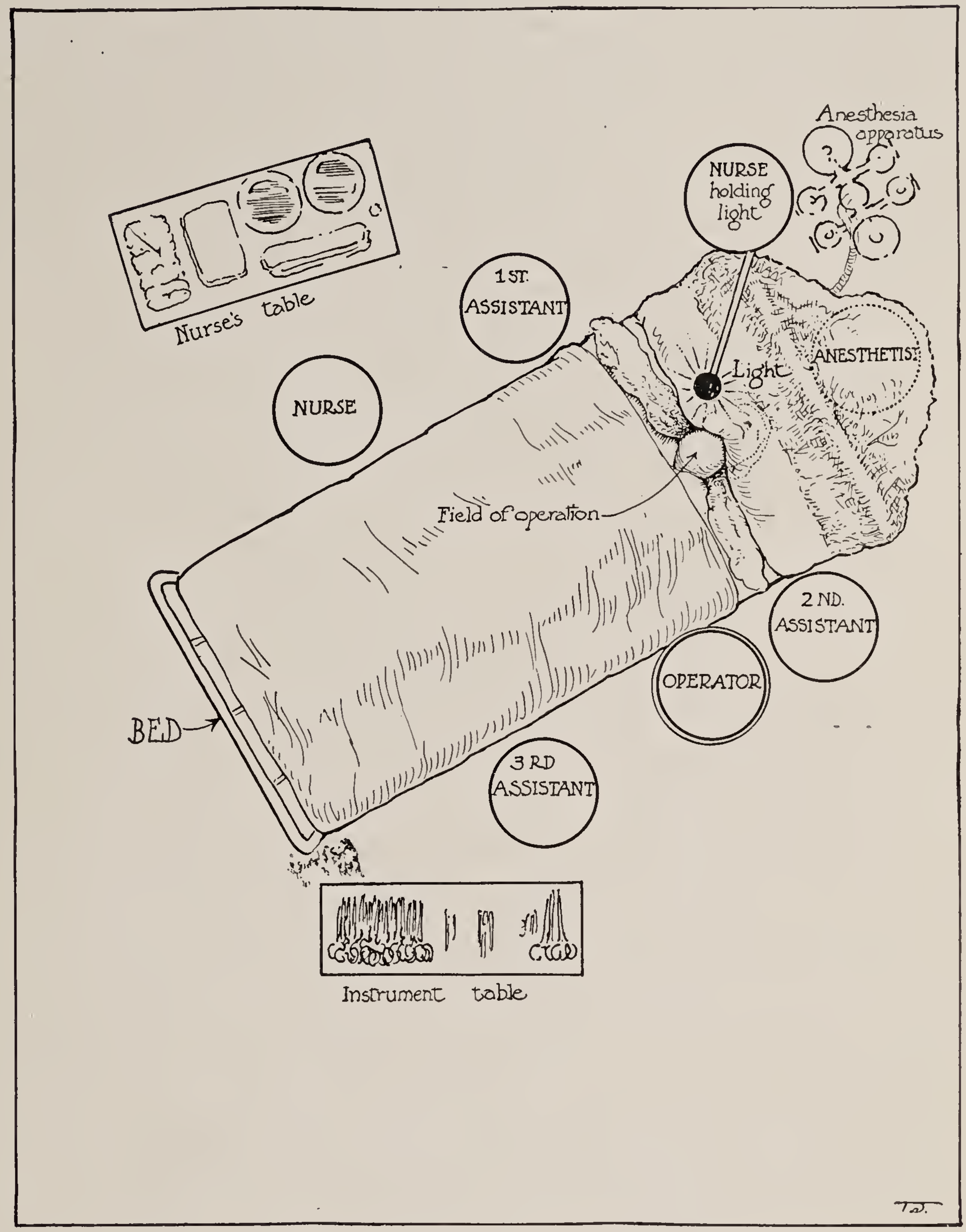

Fig. 93. Diagram of Disposition of Operating Unit in Patient's Room.

Patient does talk a little, but her voice is very thick.

Patient: "I feel it."

Anæsthetist: "Yes, you will feel a little pressure, but it will not do you any harm; it would be difficult not to feel something while having your goiter removed, wouldn't it? Let's go to sleep a minute, and forget it."

At the close of an operation under analgesia, the patient frequently reports a memory of certain procedures, but expresses a sensation of comfort without anxiety throughout. Generally, what would be painful under normal conditions, the patient under analgesia interprets merely as pressure. Pain is rarely complained of during the operation.

It is impossible to overestimate the advantages of nitrous oxide-oxygen analgesia in advanced cases of exophthalmic goiter, in which the internal respiration has been so damaged that even the mild degree of suboxidation in light nitrous oxide anæsthesia would be a menace. Analgesia specifically prevents fear, worry and anxiety, and prevents about 80 per cent of the pain due to the surgical procedures, even without local anæsthesia.

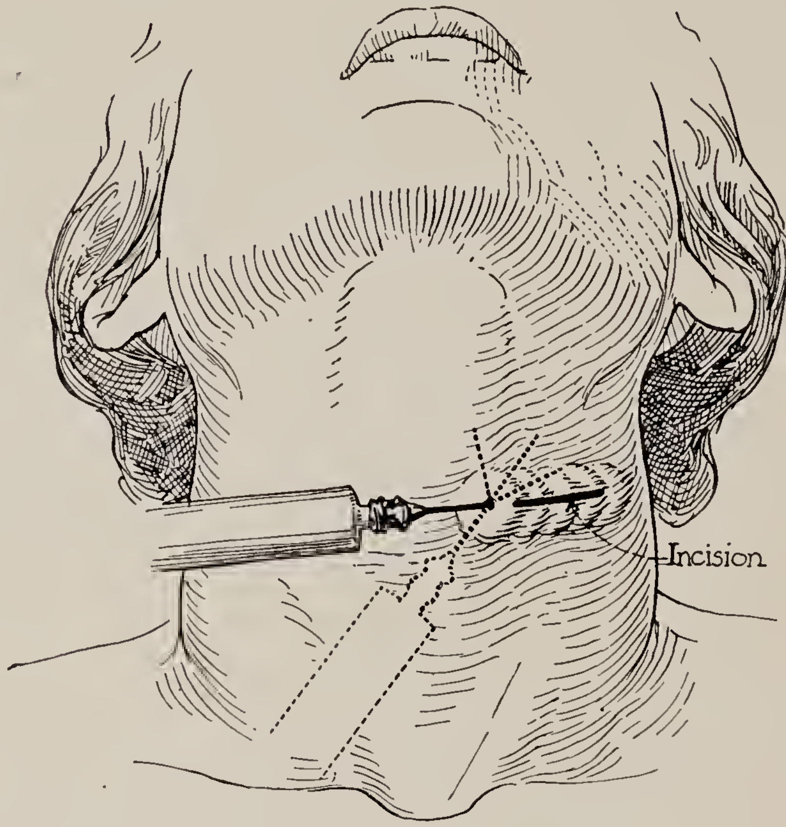

Fig. 94. Injection for Ligation of the Superior Thyroid Artery.

Local anæsthesia. Since the patient is under analgesia, it is very important that the anæsthetist warn the patient when the hypodermic needle is to be inserted the first time. After the first insertion of the needle, it should never be introduced again into an unanæsthetized region. That is, the introduction of the anæsthetic must be painless. At the point of the first insertion, enough of the anæsthetic should be introduced to puff up the skin. By pressing on this with the hand, and rubbing gently, the anæsthetized area will be enlarged, and the needle may then be introduced within this area. Throughout the operation, the local anæsthetic is introduced before cutting into any nerve-bearing tissue.

LIGATION

Ligations are always performed with the patient in bed in a comfortable position. Even the position of his head is not changed. A portable shaded electric light on the end of a stick provides ample illumination of the field. With the patient under analgesia, the skin and the area of the superior thyroid artery are infiltrated with novocaine. Complete distribution of the novocaine is assured by pressure applied vertically, transversely and around the field of injection.

The skin incision is made parallel to the folds and creases in the skin of the neck, and is carried down to the superficial fascia, which is divided vertically. The underlying muscle is exposed by the use of special retractors, and the dissection continued until the artery is seen. The artery is picked up with forceps; a needle armed with silk is passed beneath it, and the silk is tied. If there is any doubt as to whether the main trunk or only a branch of the artery has been included in the ligature, the upper pole is pulled up by the free end of the ligature, the needle is carried through again a little deeper, and another tie is made. After the ligatures have been tied, a 1/6 per cent solution of quinine and urea hydrochloride is injected just distal to and including the area of the ligation. The skin and the underlying tissues also are thoroughly infiltrated with quinine and urea. No sutures are used to approximate the cut edges beneath the skin. The skin is closed with clips in the usual manner.

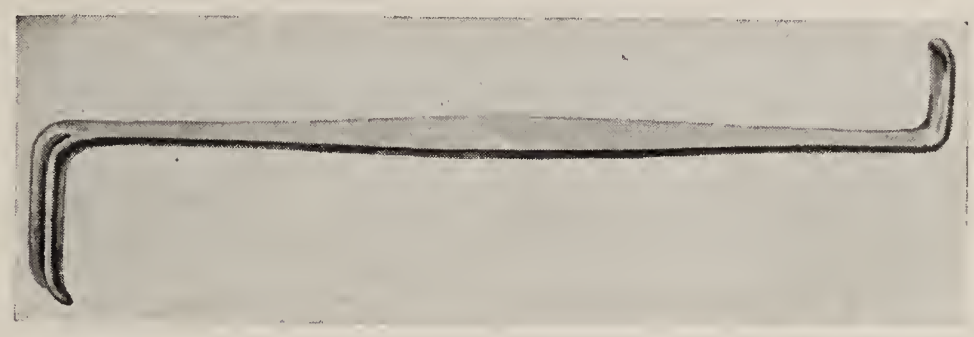

Fig. 95. Retractor Used in Ligation of the Superior Thyroid Artery.

By the time the anæsthetic effect of the quinine and urea has passed away—it lasts for four or five days—all sensitiveness in the wound will have disappeared. The patient suffers no postoperative distress; experiences no pain even on moving the neck.

There are two reasons why the superior thyroid artery is ligated in preference to the inferior. The first is that the position of the inferior artery is such that an extensive dissection is required to expose it; in fact, by the time the inferior artery is exposed, one is well on

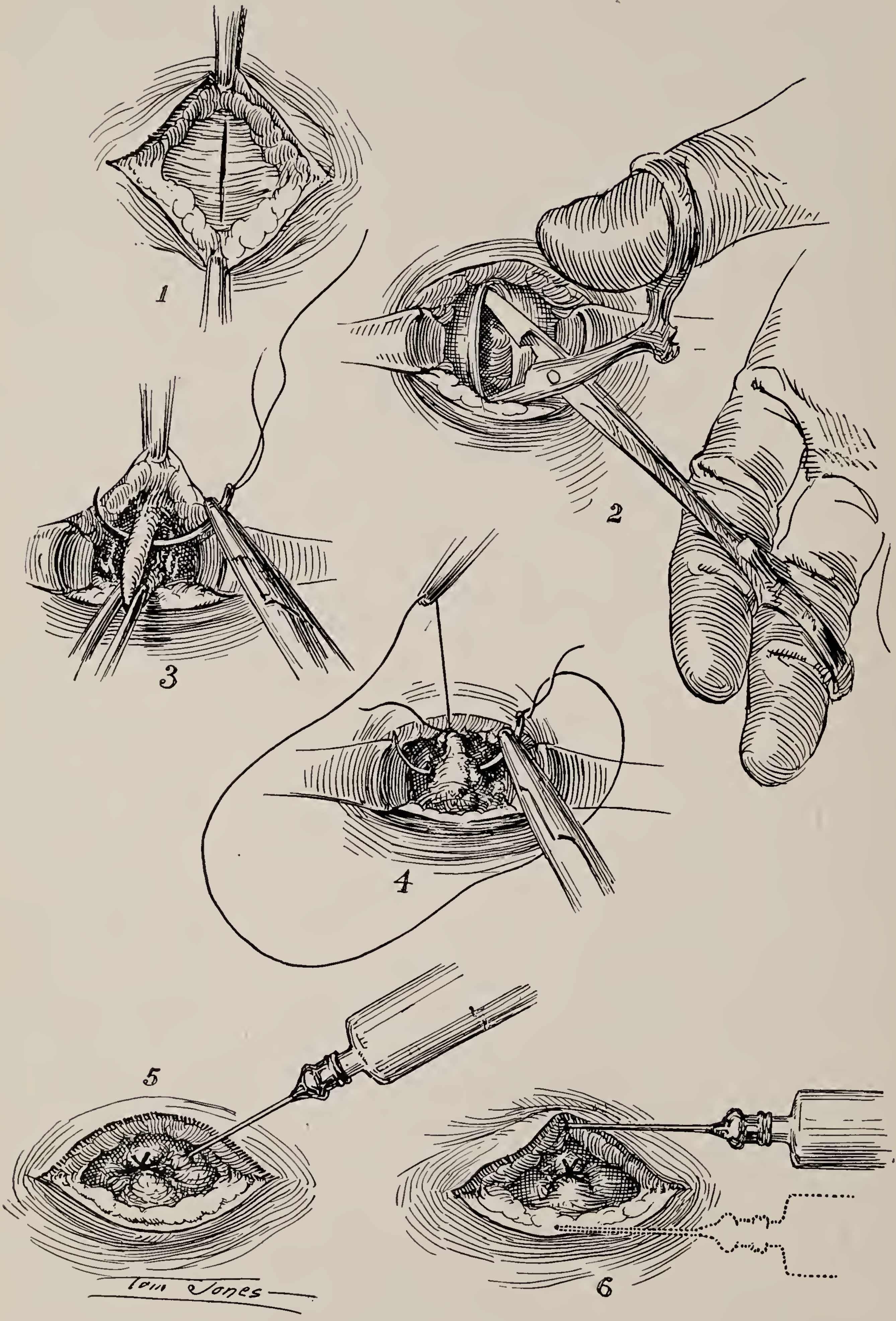

Fig 96. Technique of Ligation of the Superior Thyroid Artery

the way to a thorough resection of the gland. Ligating the inferior artery, therefore, would nullify the main reasons for the ligation, i. e., the lessening of thyroid activity with a minimum of operative trauma.

The second reason for ligating the superior artery is that a greater amount of the nerve supply of the gland passes along this artery than along the inferior artery. It is probable that the main benefit of the ligation results from interruption of the nerve supply rather than of the blood supply. In cases in which but a few days elapse between the ligation and the thyroidectomy, the blood supply appears to be but slightly diminished; if two or three months elapse, the circulation within the gland appears to be practically unchanged. Our pathologists have not been able to discover that any degeneration or other change appears in the cells of the area of the thyroid supplied

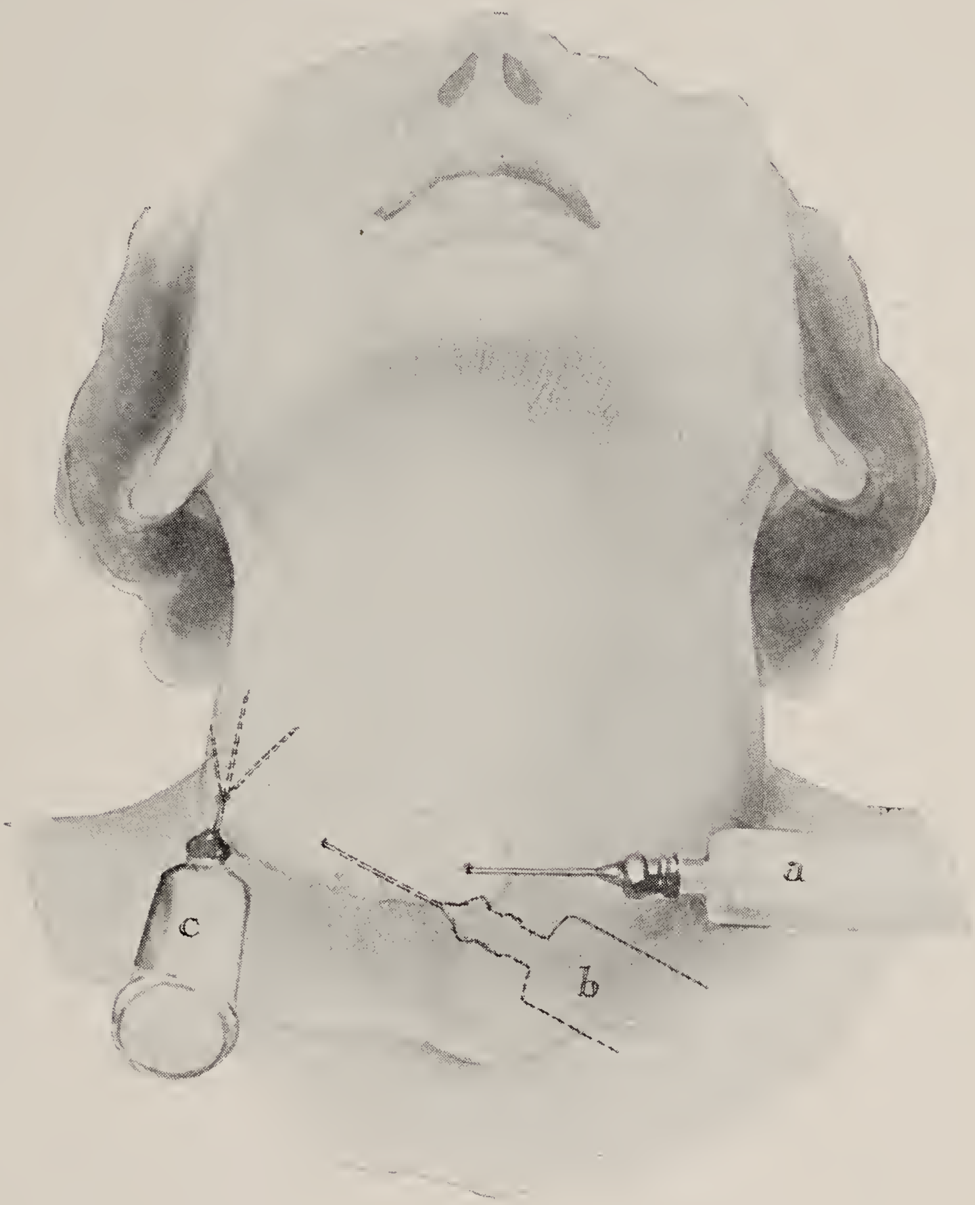

Fig. 97. Preliminary Injection Along the Line of Incision. *a, b,* Position of the syringe for infiltration of the skin. *c,* Position of the syringe for deep injection at the margin of the incision.

by the superior artery as a result of its ligation. These cells stain as readily as do any other cells in the gland. It would appear, therefore, that since the thyroid gland is principally, if not entirely, under the control of the sympathetic nervous system, the benefit from ligation is due to a lessening of the drive by interference with the nerve supply of the gland.

Whether the superior artery of each side shall be ligated at one séance depends upon the reaction of the patient to the first ligation. In an advanced case, it may be necessary to allow an interval of a few days or even longer between the two ligations. This is rarely necessary.

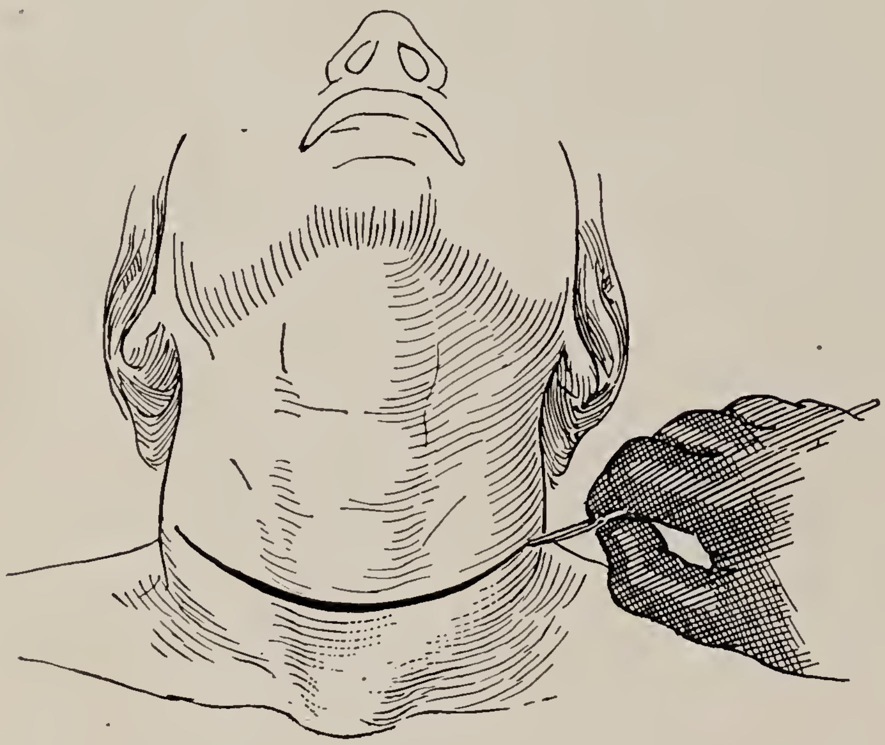

Fig. 98. Incision of the Skin with a Free Cut.

TYPICAL THYROIDECTOMY

According to the type of case, as we have stated above, the thyroidectomy is performed without removing the patient from bed, or in the operating room. With the patient under analgesia, novocaine is injected along the proposed line of incision, both superficially and deeply, so as to assure the blocking of the nerve trunks as well as the superficial fibres. The depth and area of the infiltration is increased by gentle pressure and massage with the hand·

The incision is made along the line of any of the natural folds in the neck, sufficiently high to avoid its dropping down after the goiter is removed, and being displayed on the surface of the sternum. We do not attempt to guide the knife by making the incision between

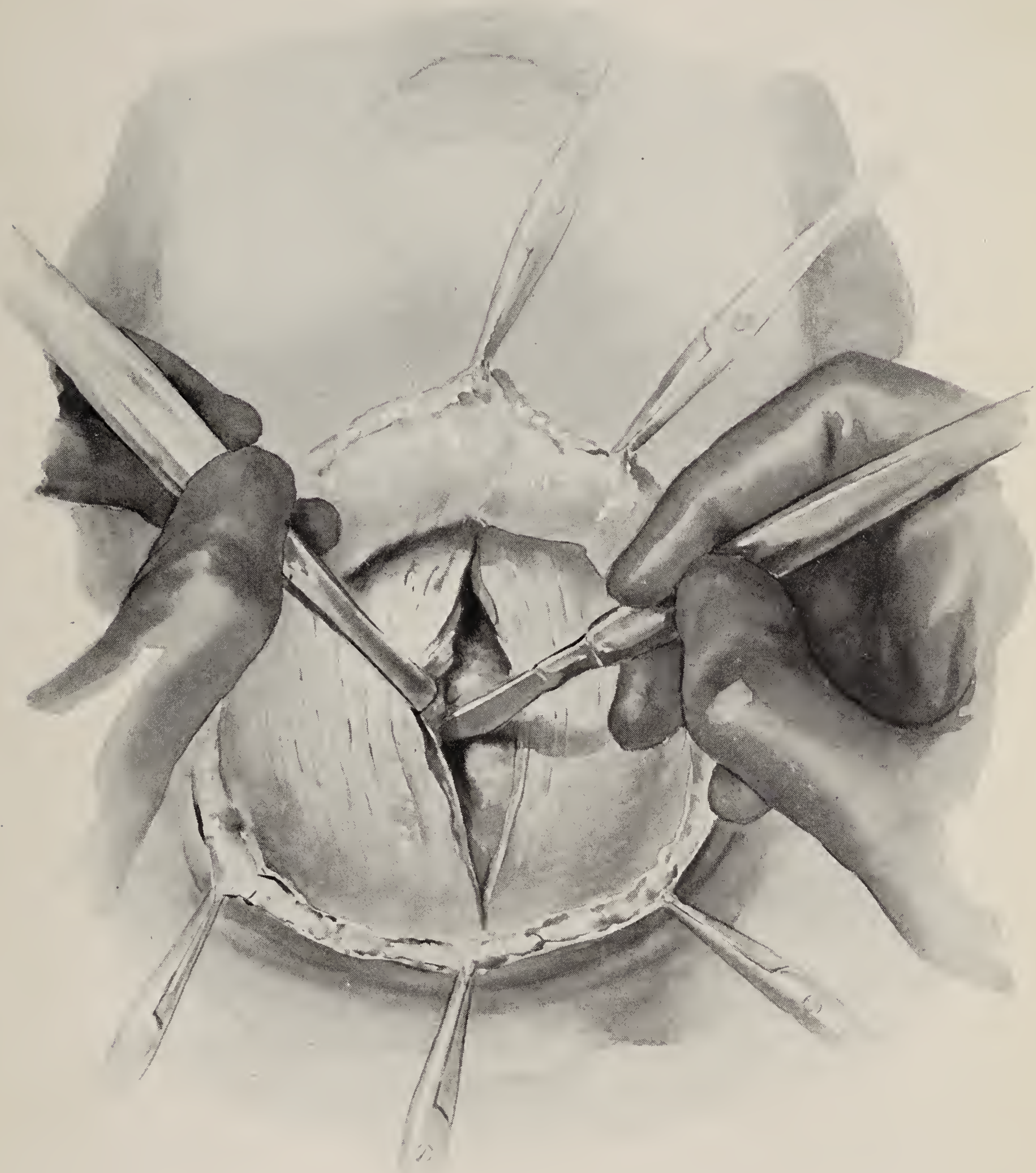

FIG. 99a. INCISION OF THE MUSCLES IN THE MIDLINE.

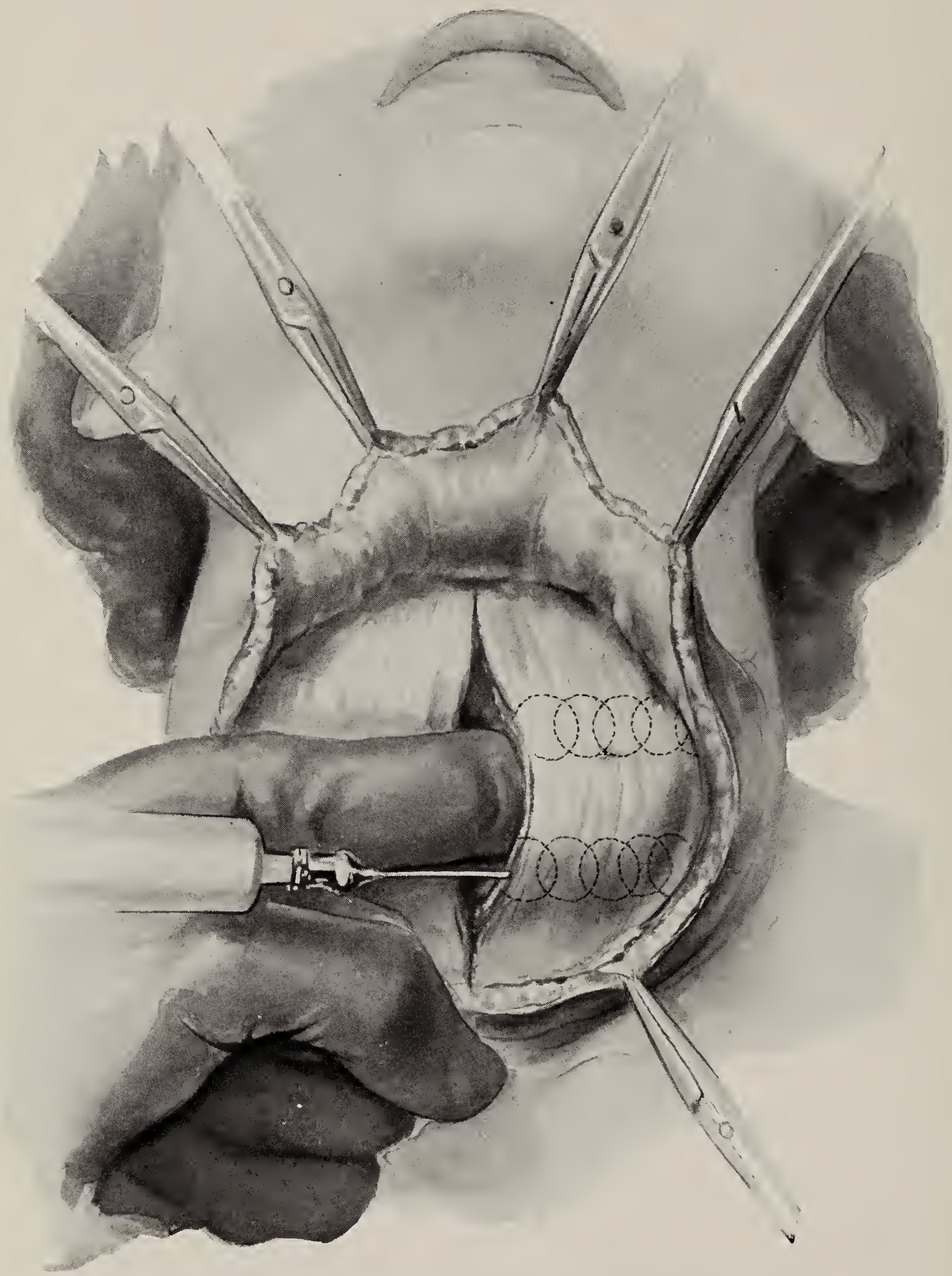

Fig. 99b. Injection of the Muscles Along the Line of Application of the Clamps.

two fingers of the other hand. This is almost certain to produce a wavering line. The best plan is to fix the eye upon the proposed line and then to make a free incision.

Whether or not the platysma shall be dissected with the skin or left behind is a matter of small consequence, provided it is re-united when the wound is closed. By reflecting the skin and the platysma together, one gains freedom.

Novocaine is then injected into the preglandular muscles, along the midline in particular, which is to be the line of incision. The nerve supply of these muscles is meagre as compared with the nerve supply of the skin, and therefore it is not so essential that the point of injection should always be anæsthetized in advance of the injection.

The muscle is divided by a vertical incision down to the gland itself, and is retracted laterally until a finger can be introduced with ease to guide the needle for the further injection of novocaine, which is introduced into every part of the muscle. The guiding finger prevents the needle from puncturing the vessels in the gland and also assures the complete anæsthetization of the portions of the muscle upon which, on each side of the midline incision, two soft clamps with longitudinal grooves are placed transversely, about the breadth of two fingers apart. The muscles on each side are divided transversely between the clamps, a short vertical incision being made at the end of the transverse incision, to assure a wide exposure of the lobe without the use of retractors. By opening these four doors, the whole glandular region —both lobes, and the superior and inferior thyroid area—is exposed completely.

Novocaine is then injected, first along the lateral margins and then throughout the whole gland, so as to assure the anæsthetization of every nerve fibre. The right lobe is infiltrated first, and then the left, as the right lobe is the first to be removed.

Sharp knife dissection is employed throughout, each vessel being caught as it is reached. The superior thyroid artery is first tied with silk—with silk rather than catgut to avoid the possible danger of its slipping off after the operation, for postoperative hemorrhage most frequently arises from this vessel, and therefore particular care in securing it is essential.

The dissection is carried from above downward, as by first dissecting the superior attachments of the gland, the entire lobe becomes mobilized and is readily brought forward. The lateral margin of the gland being thus exposed, the tissue is picked up with small hæmostats in such a way as to leave a margin of tissue from the top to the bottom of the gland, and to assure the amount to be left behind in the

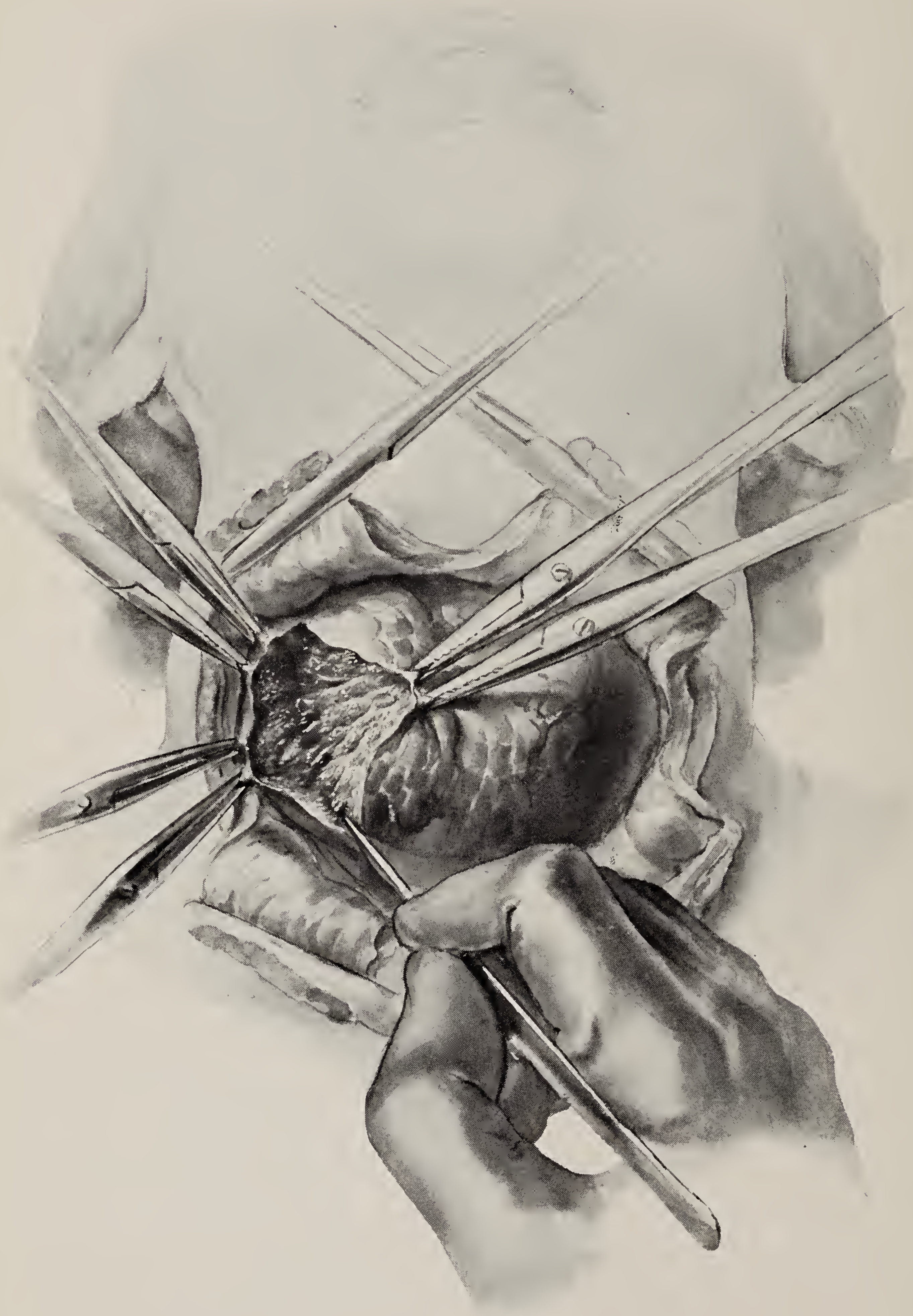

FIG. 100a. SHARP KNIFE DISSECTION OF THE GLAND.

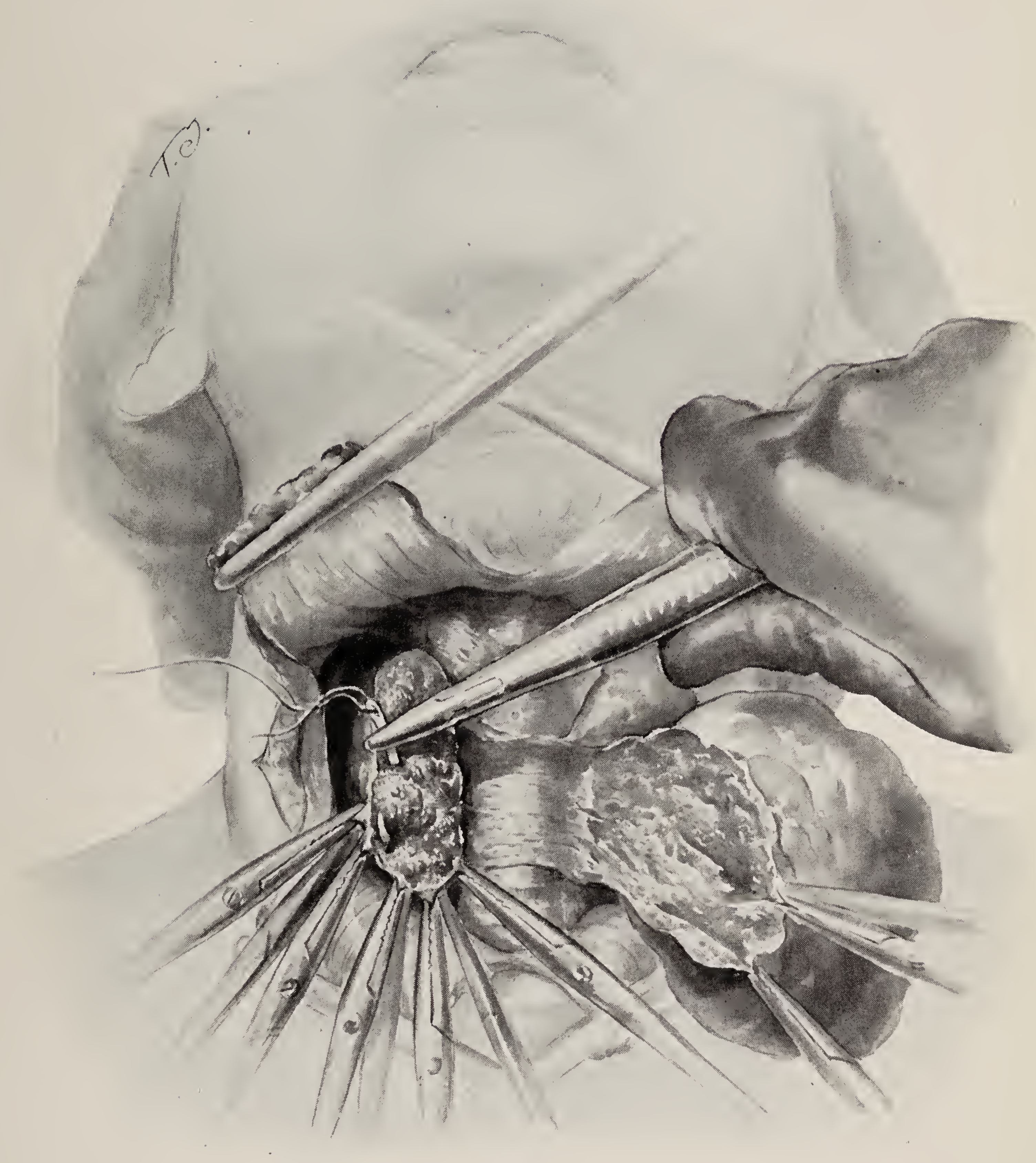

Fig. 100b. Ligation of the Stump on the Right Side. The needle is directed vertically so as not to catch the nerve.

individual case. The dissection is carried directly through the most vascular portion of the gland down toward the trachea and the larynx.

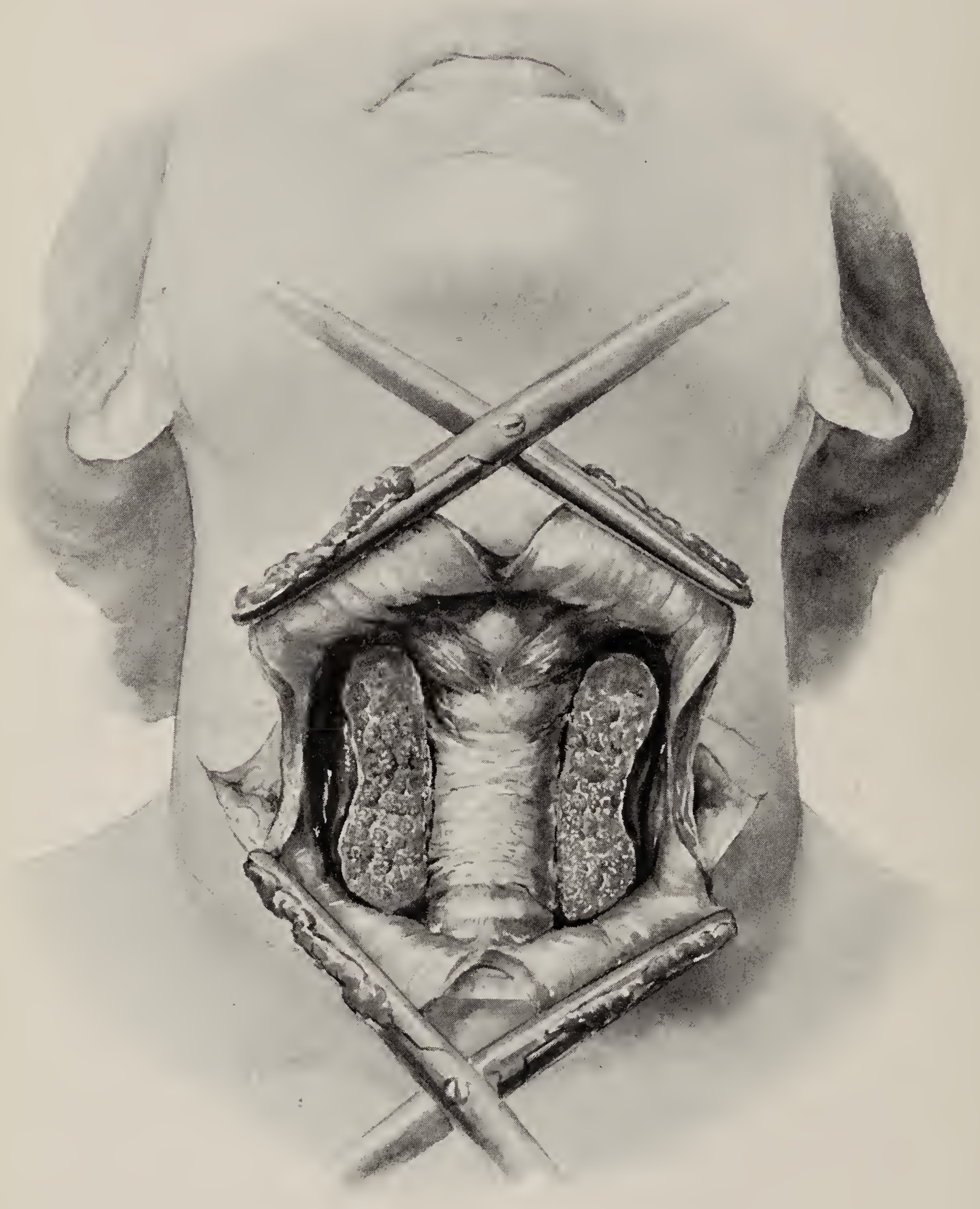

Fig. 101. Appearance of the Wound after the Removal of Both Lobes.

At this point great care is taken to leave a film of tissue over the surface of the larynx and the trachea for the purpose of protecting their nerve supply. If this is interfered with by cutting or by catching nerve fibres in the forceps when a blood vessel is cut, the immediate result will be coughing and much postoperative distress, for the stimulation of these sensory nerves will be interpreted by the brain as due to a foreign body in the trachea.

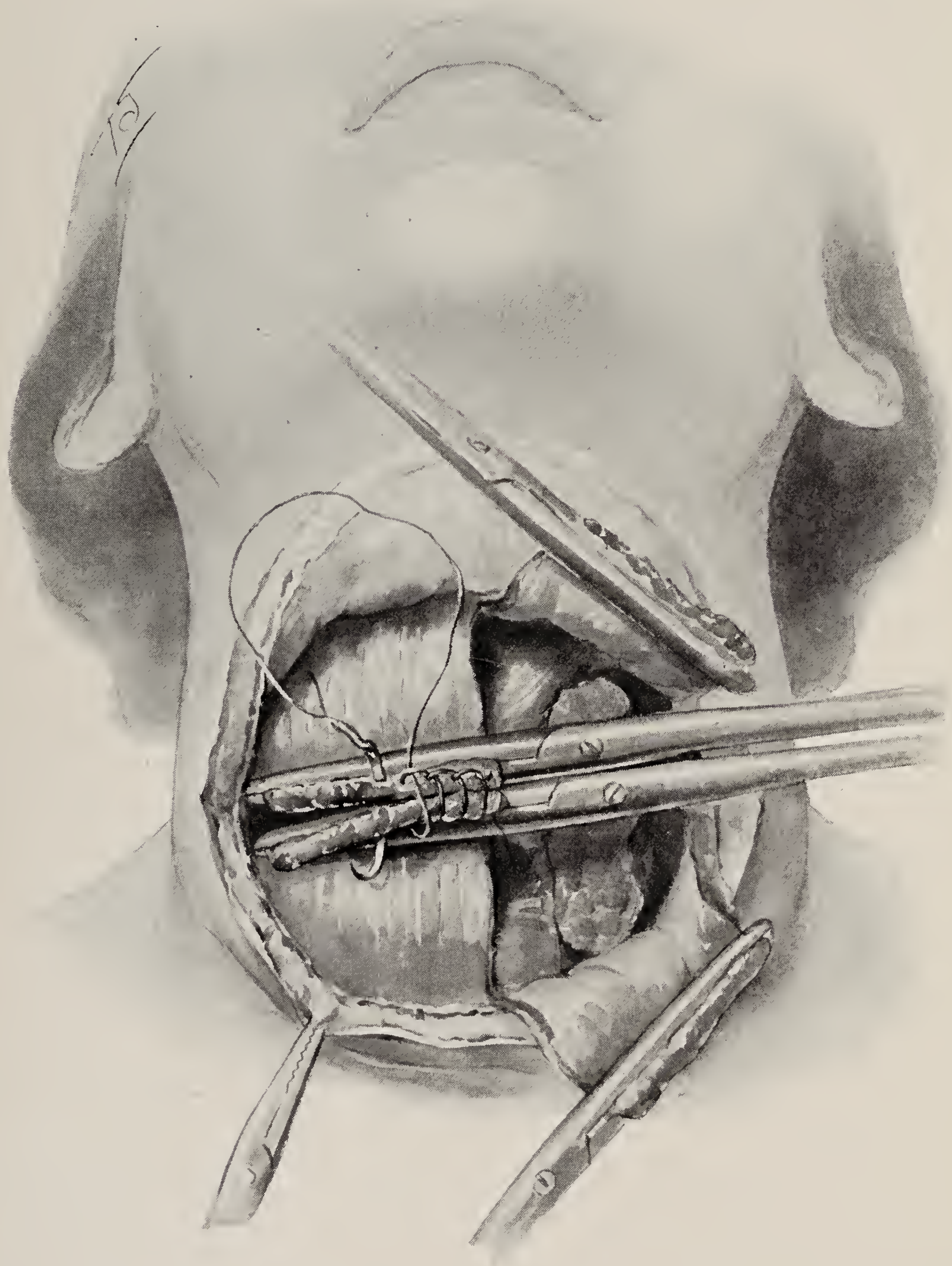

Fig. 102. Suture of the Infrahyoid Muscles by a Lock Stitch.

When the dissection and separation of the right lobe has been carried across the midline, the lobe is allowed to remain attached to the isthmus until all the vessels on the right side have been tied, so as to relieve the patient's neck from the weight of the hæmostats. Needle sutures rather than free ties are employed for tying off the vessels, the sutures being carried around small clusters of the Halsted forceps. The reason for this proceedure is that a free tie on the surface of the cut gland may slip off in case of postoperative coughing or sneezing, with resultant bleeding. Therefore, great care is exercised to make sure that the full length of the needle, and therefore of the tie, is within the gland tissue.

After the blood vessels have been secured and all forceps released, a final examination is made to ascertain whether or not there is any unevenness in the distribution of the thyroid gland tissue which has been left among the lateral margin. If that is the case, the excess tissue is trimmed off with scissors. The left lobe is then dissected in precisely the same manner, and finally the pyramidal lobe is removed. Thus the complete dissection leaves the patient with a symmetrical margin of tissue on each side without the deforming middle lobe, and with a little film of tissue on the surface of the trachea and larynx, which not only protects the nerve fibres supplying these structures, but also prevents the rings of the trachea from being seen.

Being assured that the field is bloodless, the preglandular muscles are united by a buttonhole stitch made just firm enough to hold the muscle in position. The results of dividing this muscle are negligible as far as function and appearance are concerned. The fascia is brought up into place and the vertical incision is closed, care being taken that no other structure is brought between the united surfaces of the divided fascia. A cigarette drain is inserted at the middle of the incision, being held in place by one stitch placed below it. The skin with the platysma is closed by Michel clips, the great merit of which lies in the fact that union results from ectropion of the skin, and therefore a broad firm scar is assured. The clips are removed on the third day; if left longer, the tiny wounds made by the barbs of the clips will leave a line of little white scars, which do not appear when the clips are removed on the third day.

In most cases no perceptible scar is left, the only objectionable scars being in patients subject to keloids. The drain is taken out on the morning after operation.

One would expect that so painstaking and tedious a technique as that described above must possess some special merit, as is indeed the case. First, it leaves a symmetrical margin of thyroid tissue evenly covered by the sternomastoid muscle. If there is any later hypertrophy of the remaining gland tissue, it will be symmetrical, instead of appearing as an unsightly lump at one point. Second, the margin of tissue left behind protects not only the recurrent nerves, but also the parathyroids. In fact, we aim so to plan the dissection that we shall never even see either the parathyroids or the recurrent nerves. It might appear that we would be less apt to endanger these if we exposed them fully to view. We formerly did so in a series of several hundred operations, with the result that although these patients manifested little disturbance during their stay at the hospital, aphonia later developed in two of them as a result of the inclusion of the laryngeal nerve in the scar tissue. Occasionally, also, a mild tetany

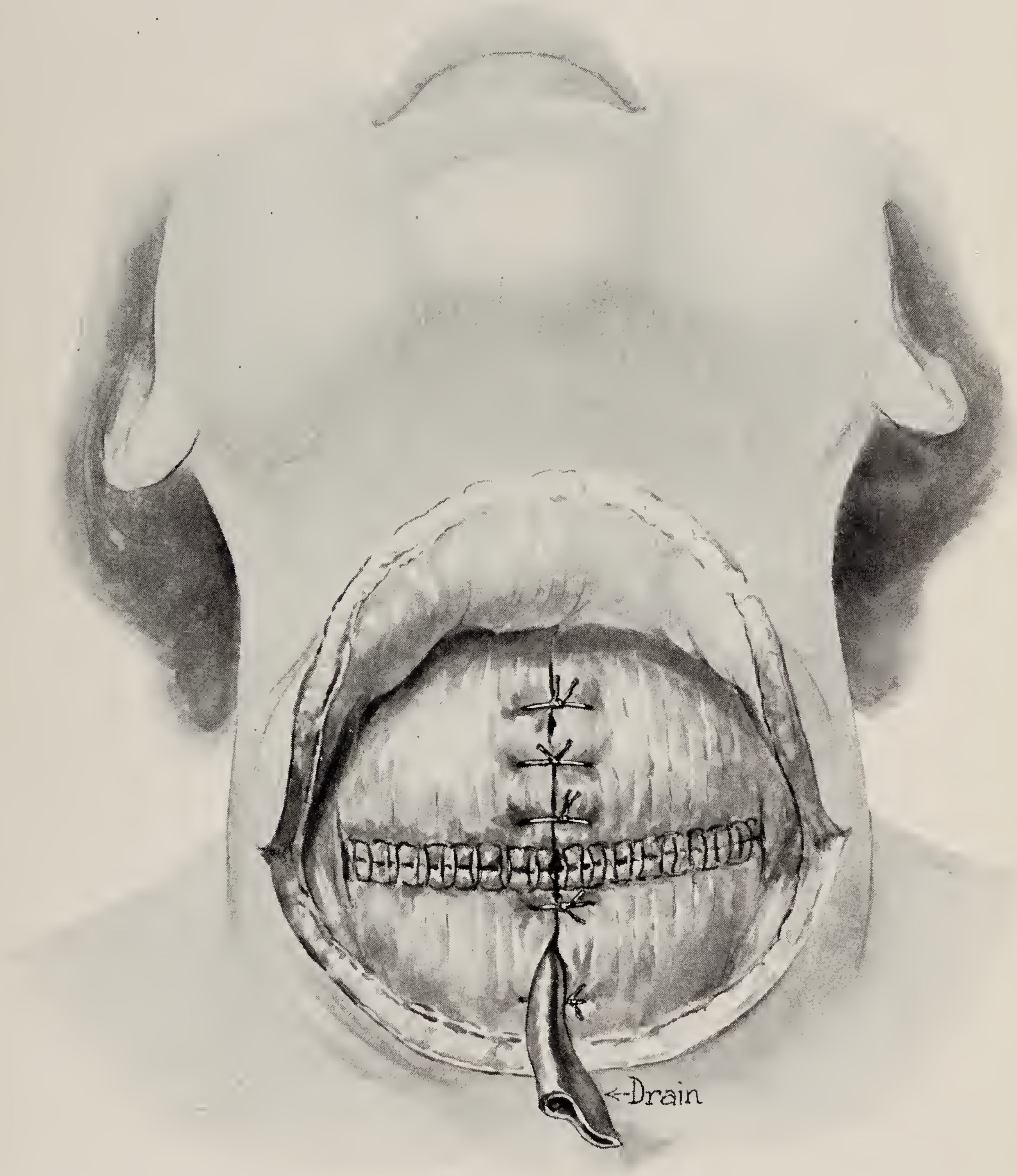

Fig. 103. Appearance of the Wound before Suturing the Skin.

would appear which could be accounted for only as the result of interference with the blood supply of the parathyroids. We then adopted exactly the opposite course—never exposing either the parathyroids or the recurrent nerves, with the result that these unfortunate sequalæ rarely appear.

Another apparently simpler method of procedure which we have discarded was the use of a few large Kocher or Ochsner forceps for control of the bleeding, rather than, as now, of the many small Halsted hæmostats.

In a series of cases in which the large forceps were used, we found that the barbs at their ends gathered in too much tissue, and prevented as definite and finished a dissection as is possible with the smaller forceps. In several operations we secured a comparatively bloodless field by catching the four main vessels with large forceps; but we found that not infrequently the recurrent nerve was dragged upon and pulled into the field with resultant hoarseness; and also that the blood supply of the parathyroids was endangered, so that an unexpected case of tetany might result.

Postoperative dressing. The wound is covered by two small gauze sponges wet with 75 per cent alcohol. Over these are placed two gauze bandages which fit snugly up beneath the chin and extend well down over the mediastinum. Adhesive tape is then placed over these dressings and passed completely around the neck, the posterior half of which has been covered by a gauze bandage to prevent the adherence of the adhesive strip to the skin and hair. This adhesive tape is applied snugly so that in case of postoperative nausea, there in no possibility of the escape of any fluid into the operative field. In addition, strips of adhesive are applied over the dressing, extending from the end of the scapula over the lateral portion of the wound to the chest just above the nipple. This aids in holding the dressing in position, and gives moderate pressure over the wound. Of many types of dressing which have been tried, this has proved most satisfactory in every respect.

VARIATIONS IN OPERATIVE TECHNIQUE

Encircling goiter. Occasionally one encounters a large bilateral gland, in which, especially if the growth occurs in a man, the overgrowth has been forced by the sternomastoid muscles on each side to penetrate the tissue between the larynx and the pharynx, and to become joined behind them. An entirely different plan of procedure must be followed in the dissection and removal of such a gland. In these cases,

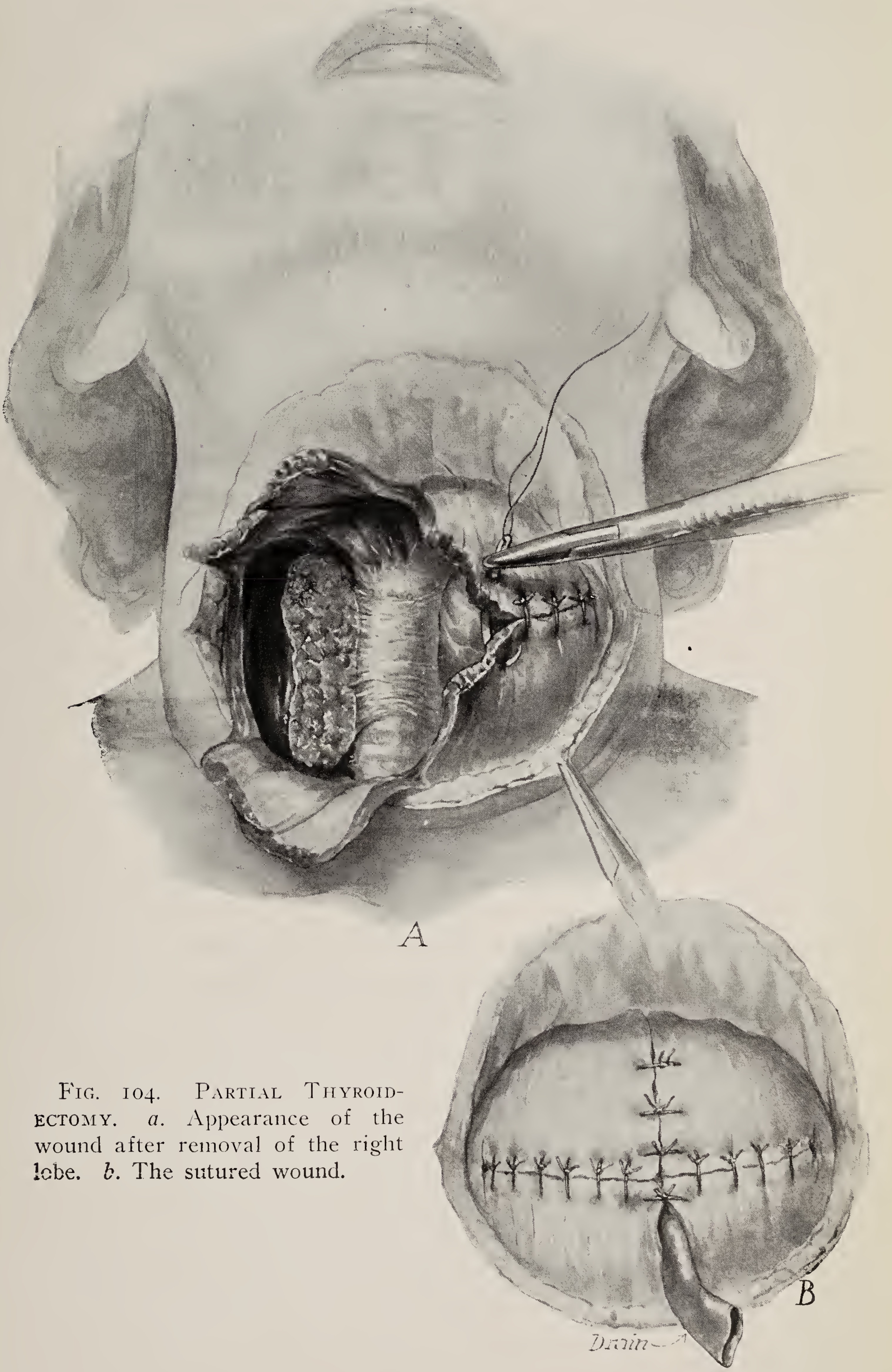

FIG. 104. PARTIAL THYROIDECTOMY. *a*. Appearance of the wound after removal of the right lobe. *b*. The sutured wound.

there is usually a strong middle lobe, so that the thyroid practically encircles the respiratory tract. Therefore, instead of the typical vertical division of the preglandular muscles and the dissection of the lobes from above downward, it is best to make a wide transverse division of the preglandular muscles and divide the thyroid itself in the midline down to the trachea. The right and left lobes are then dissected from the centre outward, great care being exercised in dividing their attachments to the deep cervical fascia and to the glands of the trachea. To put the finger up behind the lobes would make a short and easy operation for the surgeon as compared with the longer and more difficult sharp knife dissection. The danger of the simpler procedure is that traction on the lobes also produces traction on the nerve supply of the pharynx and on the recurrent nerve, the immediate effect of which may be to stop the patient's breathing and necessitate a tracheotomy, while later, unfortunate sequelæ, such as difficulty in swallowing and aphonia, may develop.

In this, as in the typical thyroidectomy, therefore, the operation is so planned as to avoid any traction upon the nerve supply of the trachea or pharynx.

Intrathoracic goiter. In certain cases no enlargement of the thyroid is apparent in the neck, but engorged veins appear around the clavicle and over the neck. This appearance indicates that the goiter has migrated into the chest. In such cases the heart and, as happened in one mammoth case, even the liver may be displaced. In some of these cases, the adenoma may have so increased in size after its descent that it can no longer be delivered through the upper entrance to the chest.

When this has happened, it is essential first of all to secure all the blood supply at the upper pole, where the attachments to the fascia will always be found. The incision is carried straight through the sternomastoid muscle so as to assure entire freedom for the dissection. If, after all the attachments to the upper pole of the thyroid have been divided, the gland cannot readily be delivered, great care must be taken to avoid dragging it up; it must rather be coaxed up by its capsule so as to advance it a little with each respiratory movement. It is not safe to try to force it by inserting the finger, for fear of rupturing veins of the pulmonary system or of the delicate wall of the gland. If the growth is too large for its delivery to be possible, then, after securing all of its blood supply, the growth must be removed piecemeal. As the adenoma is removed, the lungs will at once expand to fill its place. Avoidance of infection, then, becomes the prime consideration, for the mediastinum has a very low resistance to infection.

After the adenoma is removed, the cavity may be mopped out with iodoform water, after which an iodoform drain will form an additional protection against infection.

Special precautions in exophthalmic goiter cases. If at any point in the operation, the condition of the patient becomes unsatisfactory; the operation is stopped at that point, and the open wound is packed with flavine gauze and left *in statu quo* until the condition of the patient warrants the continuation of the operation. Thus in severe cases, after the preliminary ligations, one lobe may be resected and the resection of the remaining lobe left until equilibrium is again established; and again, after the resection of the second lobe, the wound may be left open to be closed on the following day. Thus, by consecutive periods—as few or as many as the individual case may require, it is possible to make safe an operation, all of which could not have been performed with safety at one time. In certain cases, the wound may be left open with a flavine dressing for three or four days, but this is rarely necessary. Perhaps not more than once in 200 cases have we found it necessary to leave the wound open for more than one day. The majority of wounds are closed during the afternoon of the day of operation.

In some instances after the resection of one lobe, it may be advisable to close the wound and allow the patient to go home for a period of readjustment, returning for the resection of the remaining lobe after an interval of a month or more.

POSTOPERATIVE TREATMENT OF EXOPHTHALMIC GOITER CASES

The postoperative care of the exophthalmic goiter patient has been greatly simplified by operating upon all but the mildest cases without removing the patient from his bed, by the multiple stage operation, and by leaving the wound open for secondary closure—all of which lessen to a marked degree the postoperative reaction.

Immediately following the operation, all patients perspire quite freely, so that the clothing worn during the operation becomes wet and cold. These garments are removed, and warm, dry flannels substituted before the patient leaves the operating room. The bed to which the patient is to be returned is warmed with hot water bottles. Similar precautions are taken even if the patient has not been removed from his bed for the operation.

An infusion of 2,000 c.cm. of normal saline, to which novocaine is added to make a 1/32 per cent solution (Bartlett), is given at once under the pectoral muscles by hypodermoclysis, and the patient is urged to drink abundantly and frequently as soon as possible after the operation. Morphine, if required, in younger cases, and codeine in aged patients, is given in sufficient quantities to assure the comfort of the patient.

The postoperative period of confinement to bed varies from two days in the case of a small plain adenoma to eight days in a case of severe exophthalmic goiter; after these periods the patients are allowed to be out of bed for two hours twice a day. In the majority of cases, they leave the hospital in from six to twelve days after the operation.

Upon leaving the hospital the exophthalmic goiter patient is given special instructions regarding diet, and the general need of pursuing a quiet undisturbed existence for a prolonged period.

If any postoperative evidence of myocardial deficiency is found, a course of digitalis is administered, the same as that given as a pre-operative measure, i. e., digitalis is administered hypodermically in 1/25 grain doses hourly for six hours, following which tincture of digitalis is given by mouth in 30 minim doses every four hours until 12 doses have been administered.

Postoperative hyperthyroidism is controlled by the application of ice bags. Six to eight are applied about the thorax and extremities to every patient as a routine. At the first indication of a rise in temperature, the number of ice bags is increased to 12; and if the temperature reaches 103 degrees, a complete ice pack is applied in the following manner: The patient is rolled in a linen sheet and both the patient and the mattress are covered with large rubber blankets. From 150 to 200 pounds of ice are packed above and around the patient and an ice cap is applied to his head. An electric fan, placed at the foot of the bed with the current directed toward the head, hastens the cooling process. If the rubber protection has been effectively applied, the patient will remain perfectly dry; and the temperature may be reduced as much as is desired without discomfort. Under this treatment, the temperature falls at about the rate of 2 degrees per hour; but temperature readings should be made at least every twenty minutes. Certain emaciated patients respond very much more rapidly than those with a more generous covering of lipoid tissue, and in such cases the cooling process may continue to an alarmingly subnormal level after the patient has been removed from the ice pack. Aside from this one feature, which can be guarded against by carefully watching the rate of fall of temperature, this procedure is entirely without danger.

Operative results. Since the adoption of the plan of operative management described above, the records of Lakeside Hospital show a series of 476 consecutive thyroid operations, including 331 thyroidectomies and 145 ligations, without a death. The records show also 407 consecutive operations for exophthalmic goiter without a death, including 227 thyroidectomies and 180 ligations. Among the last 500 thyroidectomies the mortality rate has been one per cent; among the last 500 ligations the mortality rate has been 0.4 per cent. These are not selected cases; but include all cases presenting themselves for treatment. No case was rejected, the series including patients in every stage of hyperthyroidism, some even with œdema of the extremities and ascites.

CHAPTER II

SURGICAL AFFECTIONS OF THE THYROGLOSSAL DUCT

A SHORT description of the development of the thyroid gland will enable us to grasp clearly the anatomy and pathology of the thyroglossal duct.

In the third week of fœtal life a bud of hypoblast appears on the floor of the pharynx between the buccal and pharyngeal parts of the tongue. This bud grows downwards into the neck and bifurcates at its lower end. The stalk of the bud represents the thyroglossal duct, while the lower end forms the isthmus and the lateral lobes of the thyroid gland. This hypoblastic bud belongs embryologically to the posterior or pharyngeal part of the tongue rather than to its anterior part and, consequently, its blood supply is from the arteries distributed to the second and third branchial arches, from which the pharyngeal portion of the tongue is developed. Thus the proximal end of the duct is supplied by the lingual artery (2d arch), while the distal end is supplied by the superior thyroid (3d arch). The distribution of the inferior thyroid artery (4th arch) to the lower part of the lateral lobe is inexplicable from a developmental standpoint. There is apparently no evidence to prove that any part of the gland is developed from the hypoblast lining the inner recess of the fourth branchial cleft.

The course of the duct is interrupted by the development of the body of the hyoid bone. It has been suggested that the duct is pinched between the anterior ends of the second and third branchial arches, which fuse to form the body of the hyoid bone. Usually there is no glandular continuity between the supra- and infrahyoid portions of the duct. Occasionally glandular communication between the two parts can be seen, either in front or behind the hyoid bone. In rare cases a distinct rod of glandular tissue can be seen passing behind the hyoid, between the upper and lower portion of the duct.

The fate of the duct under ordinary developmental conditions is complete disappearance. This is absolutely true of the suprahyoid portion. No trace of it can be discovered, except a small depression on the dorsum of the tongue, which is situated at the apex of the V-shaped row of circumvallate papillae. This depression, called the foramen cæcum, represents the buccal opening of the duct. It varies greatly in depth. Usually it is quite shallow; at times a probe can be inserted into it for a distance of several centimetres. The infrahyoid portion persists in a large proportion of cases. Usually it is represented by a pyramidal mass of thyroid

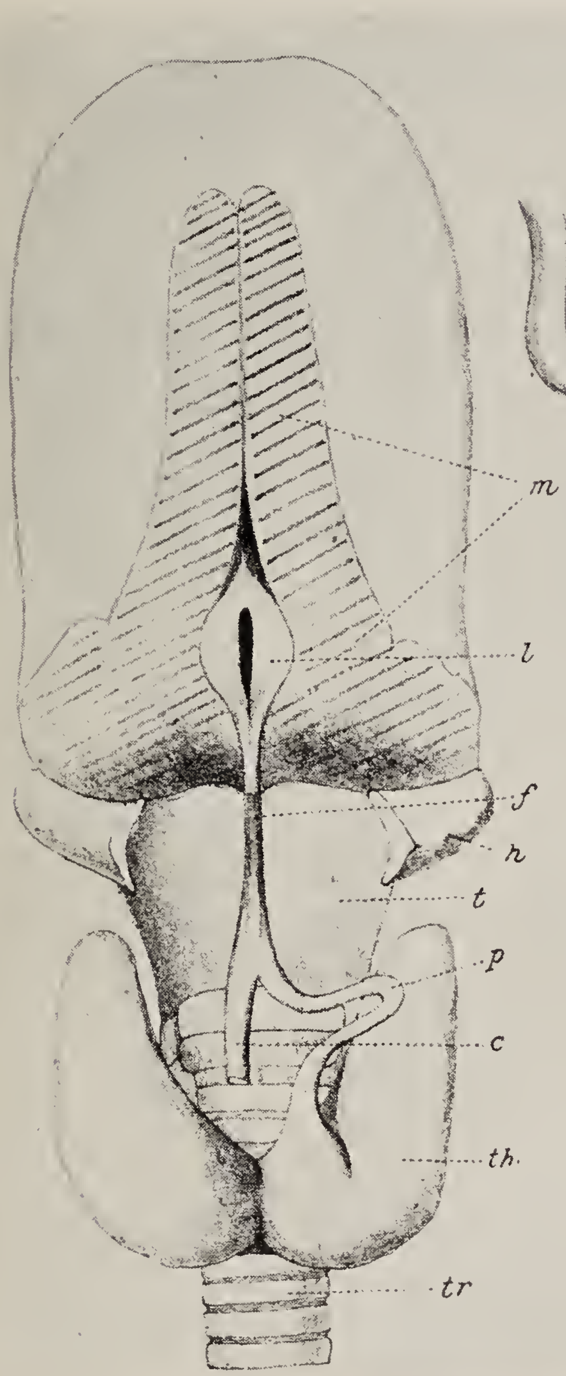

Fig. 105a. Dissection of Thyroglossal Duct, Thyroid Gland and Base of Tongue. *c*, Upper end of canal of His. *f*, Fibrous cord. *h*, Hyoid bone. *l*, Lingual duct opened and fixed by pins. *m*, Muscles cut through at base of tongue. *p*, Pyramidal lobe. *t*, Thyroid cartilage. *th*, Thyroid gland. *tr*, Trachea.

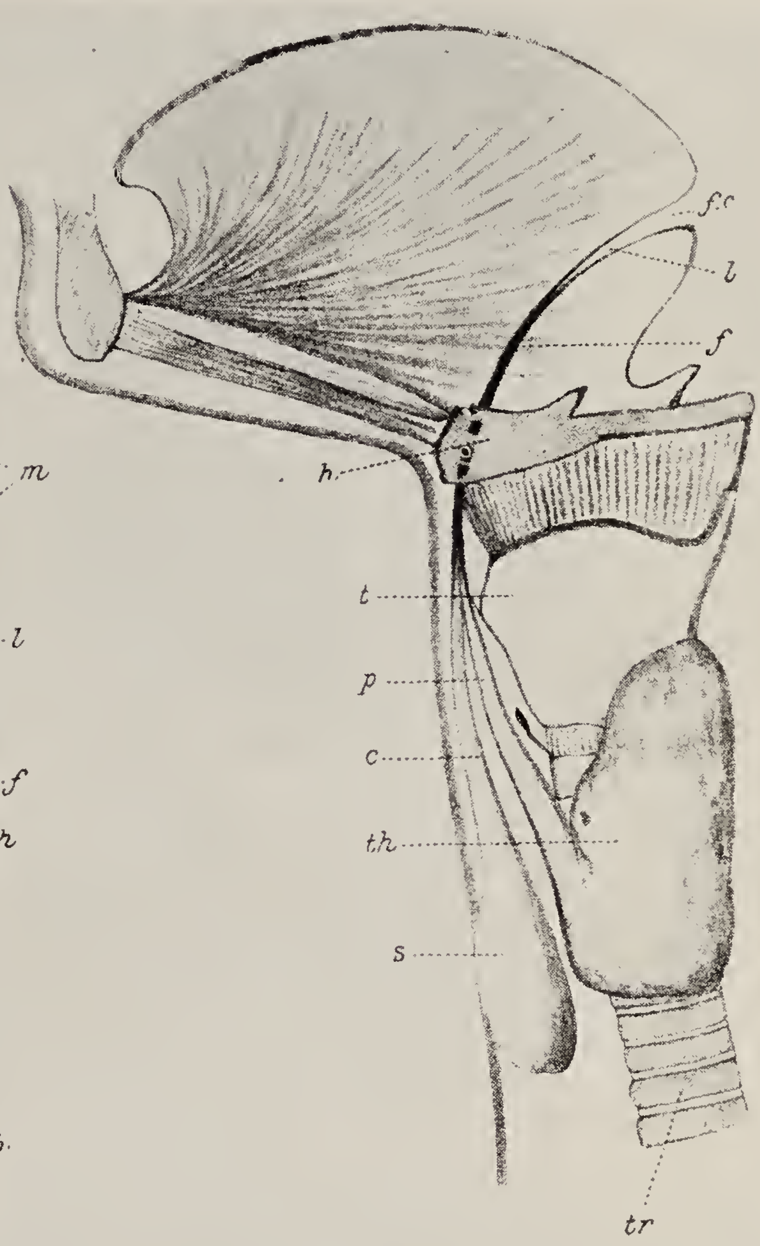

Fig. 105b. Lateral View of the Same Structures (semidiagrammatic.) *fc*, Foramen cæcum. *s*, Sac with sinus opening in front of neck. *(Marshall, J. Anat. & Physiol.)*

tissue, attached by its base to one side (the left usually) of the isthmus. The apex not infrequently extends as high as the body of the hyoid bone. In rare instances two pyramidal glandular processes have been seen, one on each side. The classical case reported by Marshall (Fig. 105) throws light on the connection between pyramidal processes and the persistence of the infrahyoid portions of the duct. "A median cyst of the neck continuous above with the glandular cord, which opened out into a patent foramen cæcum, was dissected carefully at autopsy. The lateral lobes of the thyroid gland were connected by an isthmus that seemed to belong mainly to the left lobe. From the upper side of the isthmus a pyramidal process extended upwards, the apex of which fused with the glandular cord just above the median cyst. The case was interpreted as one of complete persistence of the thyroglossal duct and both its bifurcations. Of this, the left had persisted as adult thyroid tissue (pyramidal process), whereas the right had degenerated into a sac and had lost connection with the corresponding thyroid lobe."

All pathological conditions arising in the thyroglossal duct are caused by hyperactivity of the cellular and secreting elements in persisting parts of the duct. Any part of either the supra- or infrahyoid portion of the duct may persist separately, either as a solid glandular rod, or as a duct, or as a glandular mass, or as a cyst. Canalization may occur below the hyoid bone and result in the formation of a cervical cyst, which may open on the surface of the neck by a fistulous opening. The lumen always stops short just below the hyoid bone. Similarly we may have persistence of the canal in the suprahyoid region producing a cyst in the substance of the tongue, or leaving a long fistulous channel opening above on the surface at the foramen cæcum, but blind below, just above the hyoid bone. There is no authentic case on record of the duct persisting as a patent channel throughout, from the foramen cæcum above to the fistulous opening of the cervical cyst in the neck below.

For convenience we shall describe the affections of the suprahyoid and infrahyoid portions of the duct separately, remembering always that glandular tissue may be found irregularly distributed in the neighborhood of the hyoid bone, forming a direct anatomic bridge between the upper and lower parts of the duct. These glandular bridges may be found on the dorsal or ventral surface of the hyoid; or the hyoid bone may be literally buried in the tissue. Not infrequently the wall of the thyroglossal cyst may appear to stop short of the hyoid bone and cease abruptly. These cases are often deceptive; for, in many of them, after complete excision of the cyst, mucus will reappear in the upper part of the wound within a few days of the operation. Such cases can only be cured by removal of the body of the hyoid bone and all the glandular material in its neighborhood. In several cases we have found the glandular tissue very abundant just above the hyoid bone, forming bilateral buds which burrow laterally into the substance of the hyoglossus muscle for a considerable distance. In one instance we found glandular tissue honeycombed with cystic spaces burrowing bilaterally into the hyoglossi muscles and infiltrating the geniohyoids and anterior bellies of the digastrics.

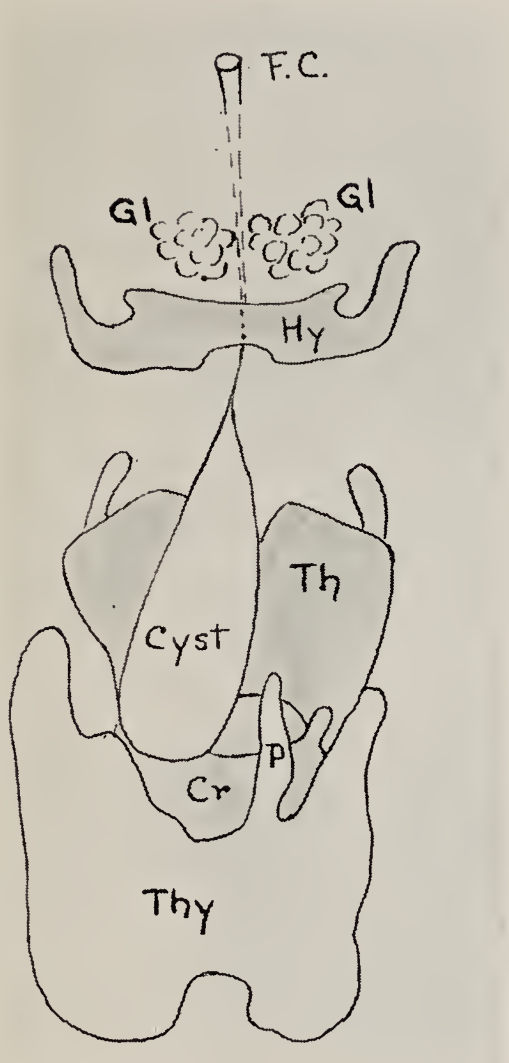

FIG. 106a. DIAGRAMMATIC REPRESENTATION OF MEDIAN CERVICAL CYST ATTACHED TO OBLITERATED GLANDULAR CORD ABOVE. Above the hyoid bone the thyroglossal duct is patent. *fc,* Foramen cæcum. *gl,* Glandular masses infiltrating suprahyoid muscles. *hy,* Hyoid bone. *th,* Thyroid cartilage. *cr,* Cricoid cartilage. *thy,* Thyroid gland. *p,* Pyramidal process of thyroid arising from the left side of the isthmus.

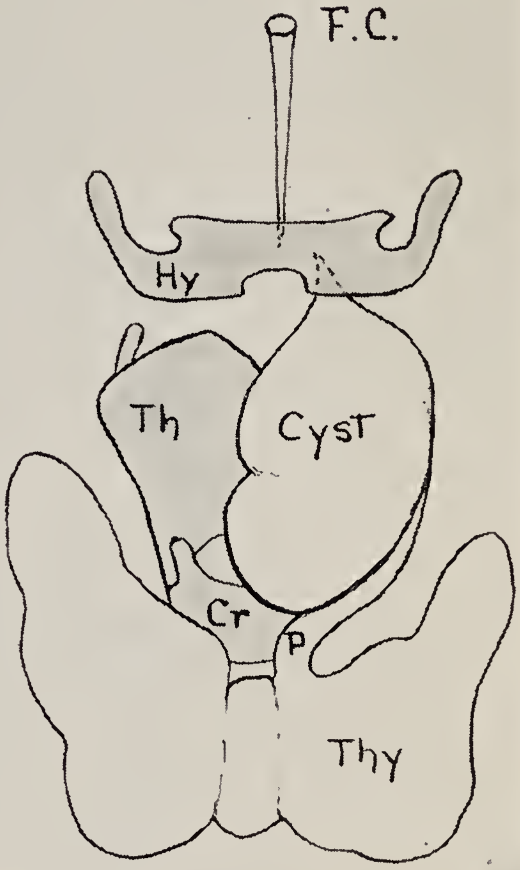

FIG. 106b. OUTLINE SKETCH OF MUSEUM SPECIMEN (UNIVERSITY OF TEXAS) OF THYROGLOSSAL CYST. The cyst is globular in shape, free from the thyroid gland and pyramid below; the apex extends behind the body of the hyoid bone. *fc,* Foramen cæcum, with suprahyoid portion of thyroglossal duct patent as far as the upper border of the hyoid bone. *thy,* Thyroid gland with a pyramidal process arising from the left side of the isthmus. *hy,* Hyoid bone. *th,* Thyroid cartilage. *cr,* Cricoid cartilage.

AFFECTIONS OF THE SUPRAHYOID SEGMENT

Persistence of the duct as a tube or as a solid rod. In a recent able article Sistrunk (*Ann. Surg.,* 1921, lxiii, 261) claims that this portion of the duct persists very frequently in association with cases of median cyst of fistula of the neck. He urges that excision of the cyst from the infrahyoid region should always be followed by removal of the body of the hyoid bone, and removal of the track of the duct from the posterior part of the tongue.

Lingual dermoids. They exist as solid tumors formed of tissue resembling thyroid gland, situated in the posterior part of the substance of the tongue in front of the epiglottis. They lie in the middle line between the two geniohyoglossus muscles. Below they may reach as low as the hyoid bone. They rarely produce much swelling in the submental region. They usually expand into the cavity of the mouth where they may be felt or seen. In size they vary. They occur more frequently in women, like ordinary goitres. They cause no pain and they grow slowly, producing no symptoms except those of obstruction. Symptoms of myxœdema are unusually frequent. In some of the cases the thyroid gland has been found missing from its usual situation (Leulier, Thèse de Paris. *Presse Medicale,* May 18, 1910).

It is wiser to abstain from operation unless the tumor is causing symptoms of obstruction. If removal is necessary, partial removal should be resorted to. Complete removal may be followed by symptoms of myxœdema. If, however, the normal thyroid can be palpated in the neck, complete removal is safe. Usually the operation can be done from within the buccal cavity. It should consist of removal of the colloid material only, which can be taken out with a sharp curette.

AFFECTIONS OF THE INFRAHYOID SEGMENT

Median cervical cyst. This affection usually appears a few years after birth as a soft, narrow, sausage-shaped swelling situated in the middle line of the neck, stretching from the lower border of the hyoid bone above to the level of the cricoid cartilage below. The contents of the cyst are thin mucus. The tendency is for the cyst to become inflamed and to open spontaneously, usually at its lower end. When this occurs, or when an incision is made into the sac, mucus will continue to discharge from the sinus indefinitely. Apparent healing and crust formation are invariably attended by reaccumulation of mucus in the cyst, followed by reopening of the sinus and the discharge of its contents. Purulent infection of the cavity is quite common. There is little or no tendency to spontaneous cure. A probe can be passed along the track as far as the hyoid bone, but no further. Injections of fluid never reach the mouth or pharynx. The cyst lies on the anterior surface of the thyroid cartilage under cover of the contiguous borders of the sternohyoid and sternothyroid muscles. It has no connection below with the thyroid gland. The wall of the cyst is continuous above with a glandular mass of tissue with no lumen, which may pass up to and fuse with the hyoid bone or may pass in front of or behind it. The cyst is often placed laterally under cover of the ribbon muscles of that side. Figure 106 represents a dissection of such a case where the cyst lay on the left side. This is interesting in the light of Marshall's case. The epithelium lining the interior of the cyst varies. In cases associated with fistulae which have discharged for a long time, it is usually absent. In intact cysts it is usually of the columnar type and occasionally it may be ciliated.

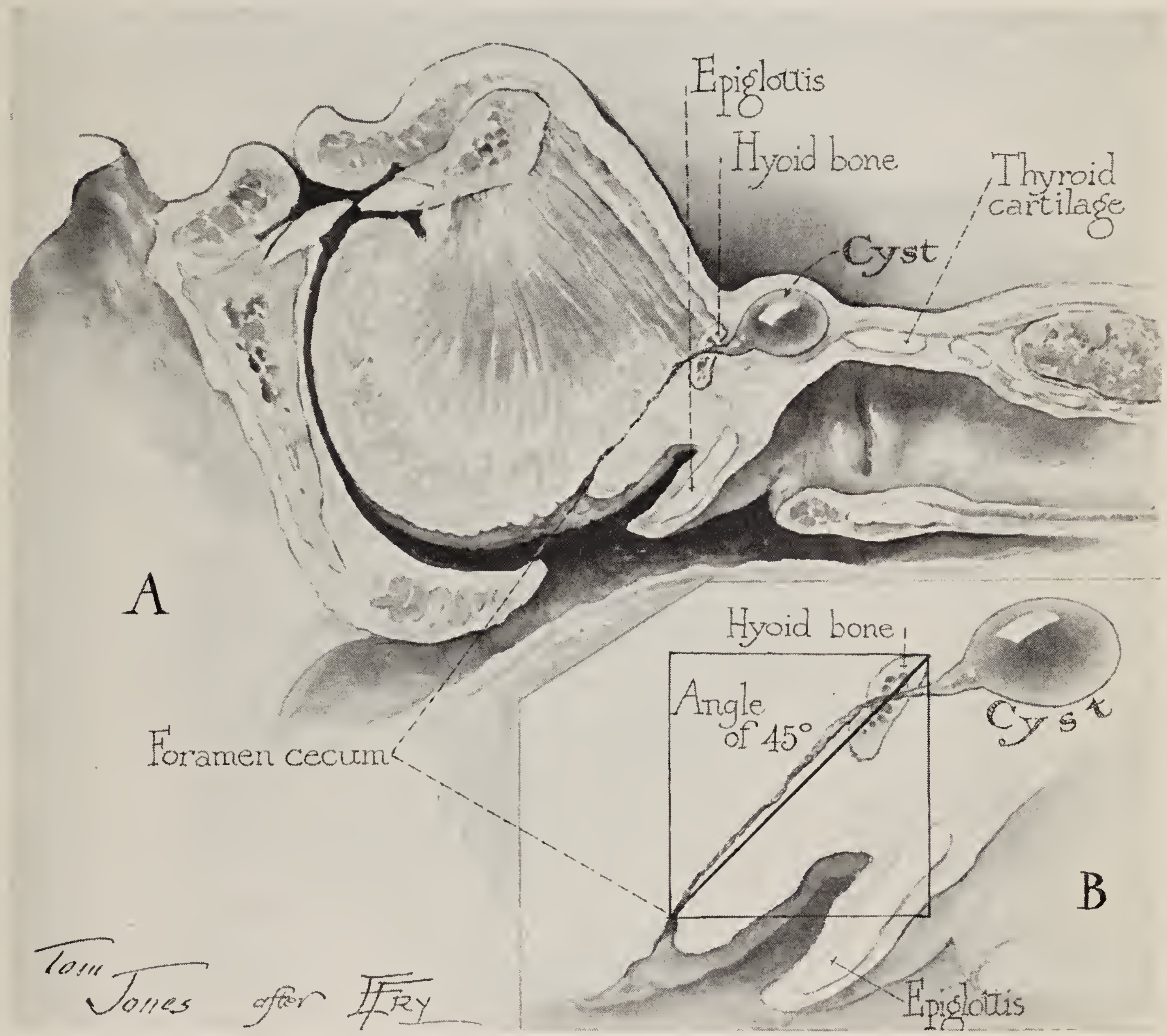

Fig. 107. Method of Dissecting Out the Suprahyoid Portion of the Duct. *(Sistrunk.)*

The only rational treatment is excision. A long median incision is the best. The cyst should be dissected out carefully from the anterior surface of the thyroid cartilage and from under cover of the sternohyoid and sternothyroid. At the upper end of the wound the anterior surface of the body of the hyoid bone should be laid bare and the dissection carried into the submental region, until the lower half of the geniohyoid muscles and the anterior bellies of the digastrics are exposed. The body of the hyoid bone is severed on each side at the level of the lesser cornu. The upper end of the cyst and the segment of the hyoid are lifted up *en masse*, and the dissection carried into the tongue between the geniohyoid and the geniohyoglossus muscles in the direction of the foramen cæcum. Every trace of the suprahyoid portion of the duct and its lateral buds must be removed completely. For this purpose it will be necessary to carry the dissection deep into the muscles of the tongue and occasionally into the submaxillary region. The removal of a core of tissue stretching from the hyoid bone to the foramen cæcum, as advised by Sistrunk, is explained in Figure 107.

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SECTION IV

OPERATIONS UPON THE BILE PASSAGES AND THE PANCREAS

BY

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CHAPTER I

THE SURGICAL ANATOMY OF THE BILE PASSAGES: GENERAL REMARKS: OPERATIONS FOR INJURY TO THE BILE DUCTS

ANATOMICAL CONSIDERATIONS

The gall-bladder. The gall-bladder is situated on the inferior surface of the right lobe of the liver in a large but shallow depression termed the cystic fossa, the peritoneum covering the under surface of the liver being reflected on to and covering the unattached fundus and inferior surface.

It is usually pear-shaped, the large extremity lying anterior to and below the neck, where it merges in the cystic duct. It varies considerably in size according to the volume of its contents. In a state of moderate distension it holds from 50 to 60 cubic centimetres of bile. Its walls are very elastic, and it is possible to introduce under pressure from 200 to 250 cubic centimetres of water without producing rupture. If the distension be continued, rupture occurs close to the neck of the organ.

The rounded *fundus,* when distended, projects beyond the free border of the liver, the margin of which presents a more or less distinct notch—the cystic notch—and comes into contact with the anterior abdominal wall close to the margin of the ninth or tenth costal cartilage immediately below the point where the outer edge of the rectus abdominis muscle crosses the costal margin.

The *body* of the gall-bladder presents two aspects, a superior and an inferior. The superior surface is in contact with the cystic fossa, to which it is united by some loose connective tissue and by vessels passing between the gall-bladder and the liver.

The lower surface is covered by peritoneum in its whole extent. It lies in contact with the second part of the duodenum and with the transverse colon. Its relations, however, vary considerably according to the state of distension of the organ. It may be pushed upwards and lie in contact with the first part of the duodenum, with the pylorus, or with the anterior surface of the stomach; or it may be displaced downwards and lie in contact with the ascending colon or the anterior surface of the right kidney. Occasionally a fold of peritoneum connects the body of the gall-bladder to the anterior aspect of the transverse colon.

The *neck* of the gall-bladder is the narrowest part of the organ. It is bent into the shape of the letter S, and maintained in this position by loose connective tissue and by the peritoneum which covers it. Internally, two inflexions give rise to the formation of two valves of mucous membrane, the lower of which separates the gall-bladder from the cystic duct.

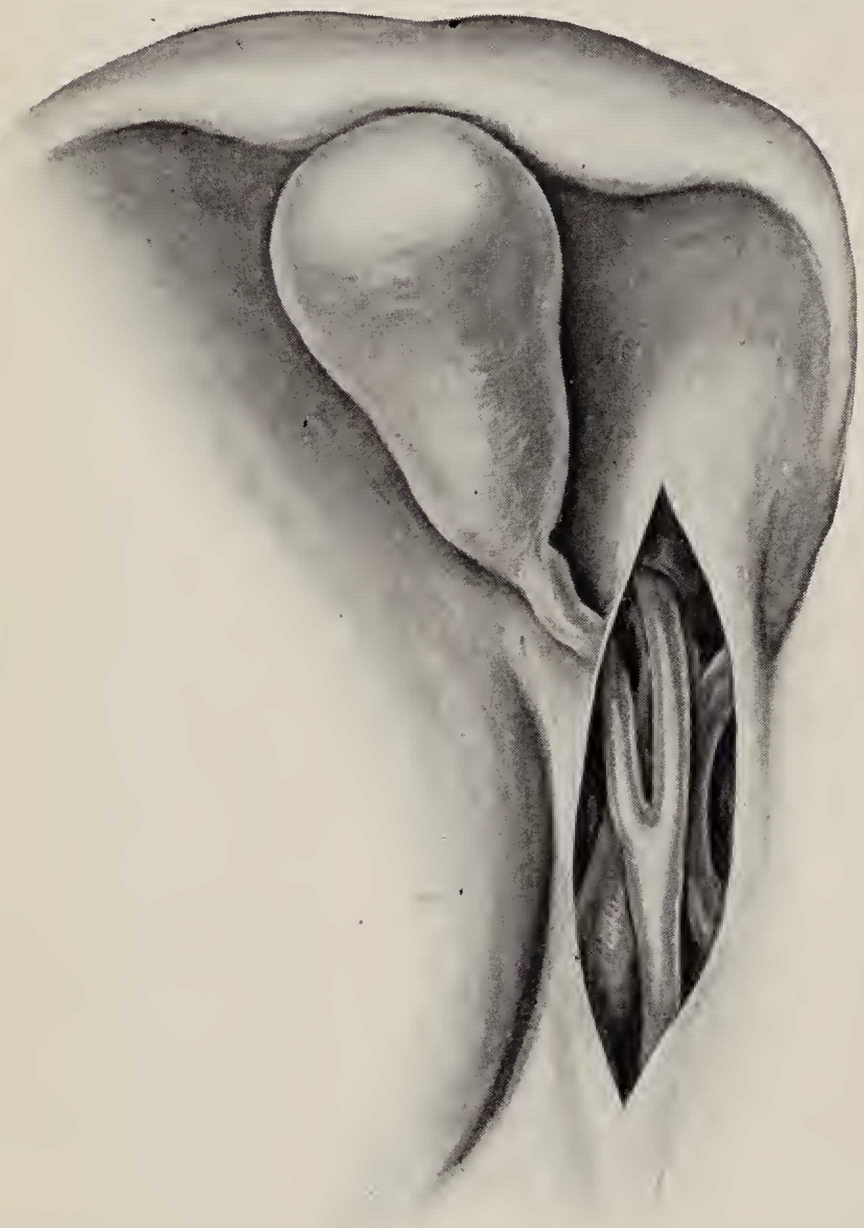


Fig. 108. The Gall-bladder and Bile Ducts.

The *serous covering* of the gall-bladder is continuous with the peritoneum covering the under surface of the liver. It covers all that portion of the gall-bladder which is not in contact with the cystic fossa. The fundus of the gall-bladder is completely covered by peritoneum, and its upper surface, unlike the body of the organ, is not in direct contact with the surface of the liver. It is separated by a double serous fold, the angle of which is formed by the reflection of the peritoneum from the margin of the liver on to the fundus of the gall-bladder.

Occasionally the gall-bladder is completely invested by peritoneum, there being on the upper aspect a distinct mesentery, which allows more or less free movement.

A much more common condition found on the operating table is the presence of a mesentery, not reaching the fundus, but extending to the lower third or half of the gall-bladder.

When moderately distended the gall-bladder is usually to be felt in the direction of a line drawn from the ninth or tenth costal cartilage and passing somewhat to the right of the umbilicus; but this position may be altered from an unusual size of the left lobe, or other structural variations of the liver, so that it may even project into the right lumbar region. On the other hand, especially where there have been repeated attacks of gall-stone colic, extending over a long period, it is more usual to find the gall-bladder smaller than normal, and occupying a position just in front of the transverse fissure of the liver. So far may this contraction go that there may be almost complete obliteration of the sac, a condition which, when extreme, may be described as cholecystitis obliterans. In these cases there is not infrequently increased difficulty in recognizing the true relation of the parts, from the adhesions of some of the surrounding organs by more or less intimate bands to the gall-bladder and liver, so as completely to hide the gall-bladder from view when the peritoneal cavity is opened.

With cirrhosis of the liver the gall-bladder is carried up well under the ribs, while if the liver is enlarged from any cause or displaced downwards by emphysema of the lungs the gall-bladder will be pushed to a lower level. I have seen it in the cæcal region and even in the pelvis.

The blood-supply of the gall-bladder is derived from the cystic artery, a branch of the right division of the hepatic artery. This vessel runs by the side of the cystic duct to the neck of the gall-bladder, and there divides into two branches, an internal and an external, which run on either side of the viscus to the fundus. In addition, the gall-bladder receives some very fine branches which come directly from the liver. The cystic veins enter the right branch of the portal vein. The nerve-supply is derived from the cœliac plexus of the sympathetic.

The cystic duct extends from the gall-bladder to the termination of the hepatic duct, with which it unites to form the common bile duct. It is from 33 to 45 millimetres in length, and has a diameter of from 3 to 4 millimetres, being narrowest at the point where it joins the hepatic duct. It resembles in structure the wall of the gall-bladder, and presents a convoluted appearance, owing to the infolding of the mucous membrane in the form of valves in the interior (see Fig. 109).

The hepatic duct originates at the right extremity of the transverse fissure of the liver by the junction of the two or three terminal biliary ducts. Thence it runs downwards and a little from right to left, to terminate in the common bile duct. The diameter of the duct measures from 4 to 5 millimetres. Its length is usually at least 3 centimetres, but it varies considerably in different subjects. These variations depend on one or other of the two following conditions: the uncertain point of junction of the terminal biliary ducts, and the high or low union of the cystic duct.

Very rarely the terminal biliary ducts, two or three in number, unite directly with the cystic duct to form the common bile duct. In such a case the hepatic duct does not exist. In its whole course the hepatic duct is situated between the two layers of the gastro-hepatic omentum. Above, at its origin, it crosses perpendicularly on their anterior aspect the right branches of the hepatic artery and the portal vein. Below, it runs on the antero-external aspect of the portal vein, which position it maintains to its termination. It is in intimate relationship with the lymphatic glands at the hilum of the liver, and also with the nerves running to the liver.

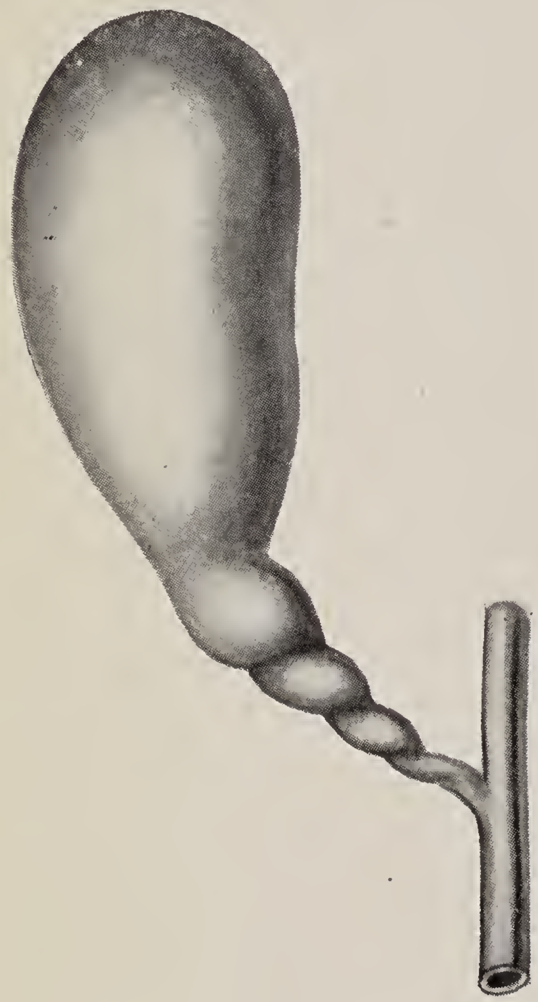


Fig. 109. Diagram to show the Convoluted Appearance of the Cystic Duct. (*Modified from Testut.*)

The common bile duct results from the junction of the cystic duct with the hepatic duct; it receives the bile from these two canals, and transmits it into the second portion of the duodenum. It runs in a direction continuous with that of the hepatic duct from above downwards a little from right to left, running behind the first part of the duodenum to the upper border of the head of the pancreas. Then it turns a little to the right and forwards within the pancreas to the postero-internal aspect of the second portion of the duodenum. It traverses the wall of the intestine, into which it opens.

It may be divided into four parts:

(*a*) The supraduodenal.
(*b*) The retroduodenal.
(*c*) The pancreatic.
(*d*) The intraparietal.

The canal in its entirety describes a curve with the concavity to the right. It varies in length from 6 to 8 centimetres, while its diameter is a little greater than that of the hepatic duct. According to Quénu, an average taken from twenty subjects gives the circumference of the duct as 13 millimetres. The common duct is very extensile, as are also the other biliary ducts, and in cases of calculus and malignant obstruction it may attain a very considerable size, so as to resemble in calibre the small or even the large intestine.

The relations of the common bile duct are of extreme importance in view of the various operations which are performed for the relief of obstruction in the duct.

The supraduodenal portion measures from 10 to 14 millimetres in length, though it may be shorter or longer, according to the point of junction of the hepatic and cystic ducts. It runs in the free border of the gastro-hepatic omentum immediately in front of the foramen of Winslow. Here it lies on the antero-external aspect of the portal vein, while the hepatic artery is to its inner side. A small branch of the pancreatico-duodenal artery crosses part of the duct just above the duodenum. A chain of three or four lymphatic glands lies in contact with the supraduodenal portion of the common bile duct, their vessels passing to the glands in the transverse fissure of the liver.

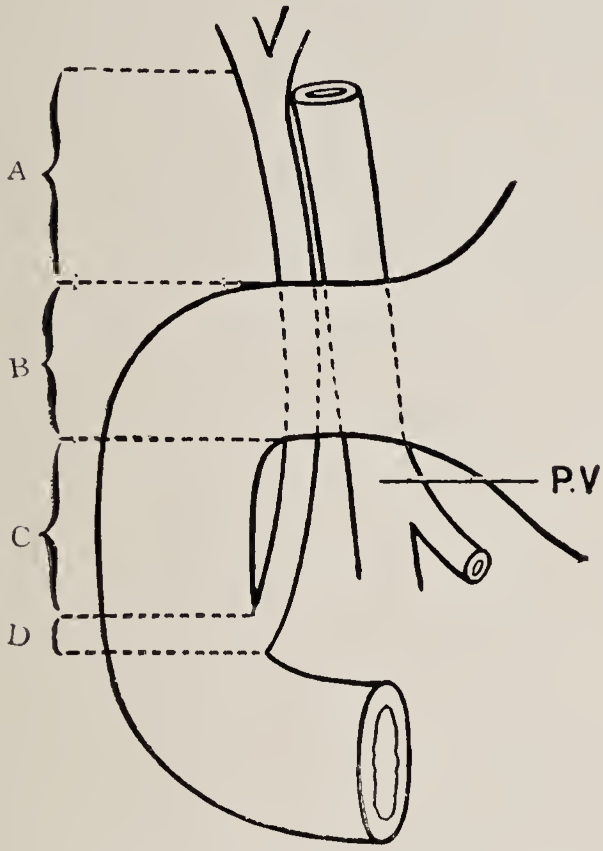


Fig. 110. Diagram to show the Four Divisions of the Common Duct. a, The supraduodenal; b, The retroduodenal; c, The pancreatic; d, The intraparietal.

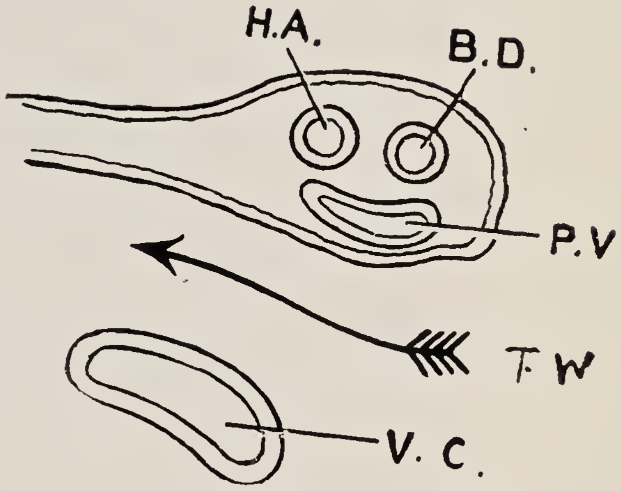


Fig. 111. Diagram to show the Relation of the Common Bile Duct in the Free Border of the Lesser Omentum. b.d., Bile duct; f.w., Foramen of Winslow; h.a. Hepatic artery; p.v., Portal vein; v.c., Vena cava.

The retroduodenal portion corresponds to the posterior aspect of the first part of the duodenum, to the wall of which it is closely applied. The portal vein lies to its inner side, while behind it is the inferior vena cava.

The pancreatic portion is the name applied to that portion of the common bile duct which extends from the inferior border of the first part of the duodenum to the point where the duct penetrates the wall of the second part; it measures from 20 to 25 millimetres in length.

This portion of the common duct crosses a small quadrilateral area, bounded above by the inferior border of the first part of the duodenum, below by the superior border of the third part, externally by the internal border of the second part, and internally by the superior mesenteric vein. It is here closely applied to the pancreas, in some cases being completely surrounded by pancreatic tissue, in others lying in a pronounced groove on the posterior surface of the gland.

Bunger (*Med. Press*, 1902, p. 523), in a careful examination of fifty-eight subjects, found in 25% the duct ran in a groove in the gland, while in 75% it was completely enclosed by pancreatic tissue.

According to O. Wyss, the common bile duct ran in a groove on the posterior surface of the head of the pancreas in fifteen out of twenty-two bodies examined (68.1%), and it was surrounded by the tissue of the pancreas on all sides in the other seven bodies (31.7%). This anatomical condition is important, inasmuch as swelling of the pancreas will in the first case push the common duct out of the way without compressing it, while in the second case compression leading to occlusion may easily take place where the duct passes through the head of the pancreas.

This portion of the common duct is in close relationship with the inferior vena cava.

The intraparietal or interstitial portion of the common duct comprises all that portion of the canal contained in the thickness of the wall of the duodenum. It passes obliquely through the muscular coat of the intestine, and then dilates into a little reservoir underneath the mucous membrane, into which the main pancreatic duct also opens. This is known as the ampulla of Vater. This ampulla, a little oval cavity, may be well seen in a section of the wall of the duodenum in the axis of the common duct (see Fig. 112). The opening of the common duct is above that of the pancreatic duct, and the two are separated by a small transverse fold of mucous membrane. The ampulla measures from 6 to 7 millimetres in length and from 4 to 5 in breadth, and, with the termination of the two ducts is surrounded by a thin layer of unstriped muscular tissue, forming a sphincter (Oddi). The ampulla opens into the duodenum by a little round or elliptical orifice, which is the narrowest part of the bile channel. It is important to note that the length of the diverticulum of Vater may vary from zero to 11 millimetres, the average being 3.9 millimetres, according to Opie, who measured 100 specimens. Viewed from the interior of the duodenum the ampulla forms a rounded eminence of the mucous membrane, known as the caruncula major of Santorini, the opening being seen at the apex of the caruncle. It is distant 8 to 12 centimetres from the pylorus. Above it there is constantly found a small transverse fold of mucous membrane, which must be raised in order that the caruncle and its orifice may be clearly seen. Running downwards from the caruncle is a small vertical fold of mucous membrane known as the frenulum carunculæ. Above the caruncula major is found a smaller eminence, the caruncula minor, marking the termination of the accessory pancreatic duct.

An accessory pancreatic duct or duct of Santorini opens into the duodenum about ¾ inch above the biliary papilla; it is patent in about 50% of cases, and in over 80% it communicates with the duct of Wirsung.

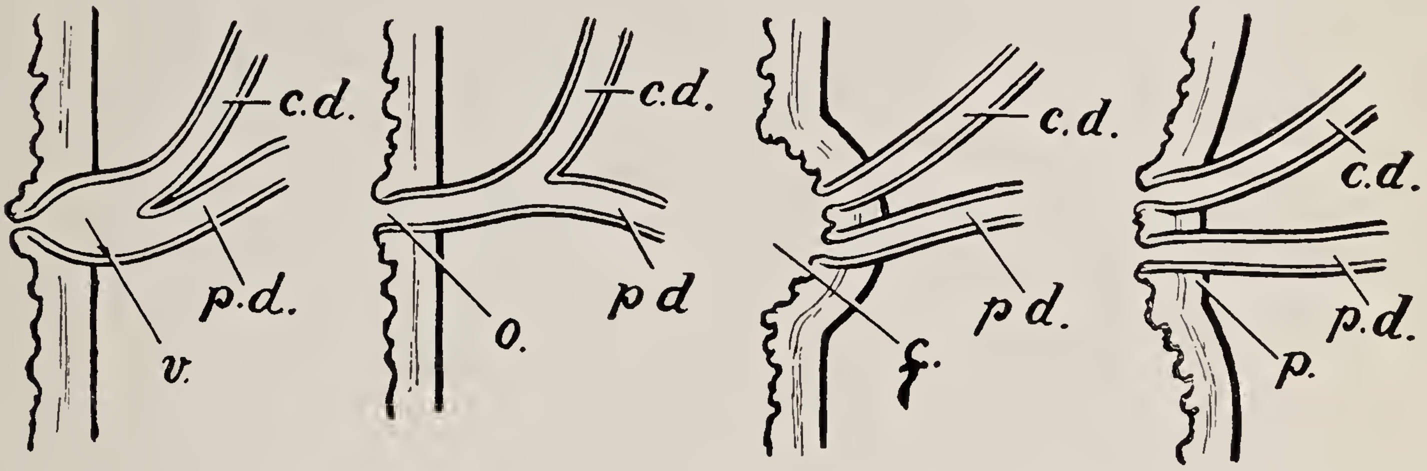


FIG. 112. DIAGRAM TO SHOW THE FOUR CHIEF VARIETIES IN THE TERMINATIONS OF THE BILE AND PANCREATIC DUCTS IN THE DUODENUM. *c.d.*, Common duct; *f.*, Fossa; *o.*, Oval orifice; *p.*, Papilla; *p.d.*, Pancreatic duct; *v.*, Ampulla of Vater.

The mode of formation of the ampulla of Vater and the termination of the common and pancreatic ducts are liable to great variations. Letulle and Nattan Lorrier distinguish four types.

The *first type* is the classical one described above (see Fig. 112).

In the *second type* the pancreatic duct joins the common duct some little distance from the duodenum, the ampulla of Vater is absent, and the duct opens into the duodenum by a small flat, oval orifice.

In the *third type* the two ducts open into a smaller fossa in the wall of the duodenum, while the caruncle and the ampulla of Vater are both absent.

In the *fourth type* the caruncle is well developed, but the ampulla of Vater is absent, its two ducts opening side by side at the apex of the caruncle.

Other variations described in my work on the pancreas so rarely occur that they need not be mentioned here.

In structure the common duct resembles the other biliary ducts, its blood-supply and innervation being the same as those of the hepatic duct.

Congenital malformations. There is apparently no part of the biliary apparatus, except the liver, which may not be absent. While this is not specially to be wondered at in the case of the gall-bladder and cystic duct, since they are normally wanting in certain animals, and are frequently obliterated by disease in the human subject, it affords serious food for thought to find that life has been possible for six months where even the hepatic and common ducts are represented by mere fibrous cords (as in Specimen No. 973 (see Fig. 113) in St. Mary's and No. 1017 in King's College Museum).

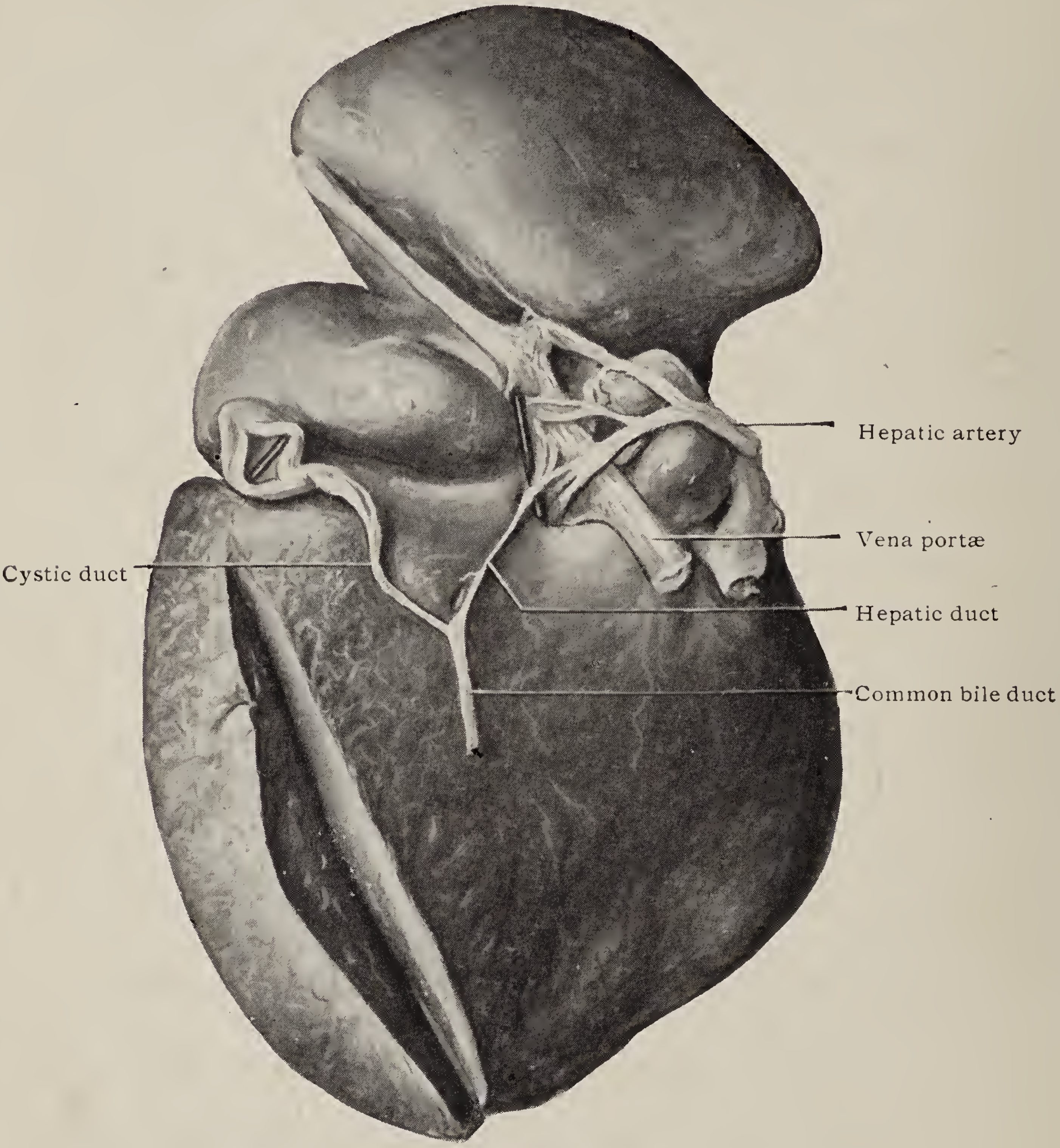


Fig. 113. Congenital Obliteration of the Bile Ducts.

Hour-glass-shaped gall-bladder is probably not uncommon. I have operated on several.

Occasionally the distal part of the gall-bladder contains calculi, and communicates by a narrow neck with the cyst proper, or the distal portion may simply contain mucus and the proximal sac one or more calculi.

In some instances the condition arises from contraction of an old ulcer, but in others, the mucous membrane being smooth, and showing no evidence of cicatrization, the deformity appears to have been congenital.

In the *Annals of Surgery* for May, 1899, is related a case in which there was transposition of viscera, and as the patient was the subject of gall-stones, cholecystotomy was successfully performed on the left side.

In palpating the common duct for gall-stones, the surgeon frequently feels several more or less hard nodules within the free border of the lesser omentum, by the side or in front of the common duct, and unless it be borne in mind that three or four lymphatic glands normally exist here, they may be apt to mislead, especially as they are not unusually considerably enlarged where there is gall-stone irritation. Frequently they are as large as beans, and at times the size of filberts.

The large peritoneal pouch, bounded above by the right lobe of the liver, below by the ascending layer of the transverse mesocolon covering the duodenum internally, externally by the peritoneum lining the parietes down to the crest of the ilium, posteriorly by the ascending mesocolon covering the kidney, and internally by the peritoneum covering the spine, has been long recognized, but perhaps not sufficiently appreciated in gall-bladder surgery. Mr. Rutherford Morison drew attention to it in a paper in the *British Medical Journal* for March 3, 1894.

It is possible to drain this pouch by means of a long glass tube, but it is safer to make use of a lumbar drain. It is interesting to note that the pouch is capable of holding nearly a pint of fluid before it overflows into the general peritoneal cavity through the foramen of Winslow or over the pelvic brim.

A deformity of the liver, congenital or acquired, may at times lead to a difficulty in diagnosis or in treatment. The common form is a tongue-shaped prolongation of the right lobe, which may project below the costal margin for several inches, and simulate a tumour of the liver or an enlarged gall-bladder.

In some instances the gall-bladder projects beyond the apex of the linguiform projection, in others the dilated gall-bladder lies under cover of the projecting lobe, which is thinned and spread out over it.

In one of my cases the gall-bladder and linguiform process of the liver reached the cæcal region, and the recurrent attacks of pain, associated with local peritonitis and unaccompanied by jaundice, much resembled recurring appendicitis, the point of greatest tenderness being situated midway between the umbilicus and anterior superior spine of the ilium, in which position the incision for the operation was made.

In others, the projection is external to the gall-bladder, which is then found lying on its inner side.

In a case of this kind, where the gall-bladder is contracted and calculi are impacted in the cystic duct, there may be the greatest difficulty in extracting them, owing to a limitation of the space for manipulation caused by the abnormality, unless the liver be lifted up.

I believe that Professor Riedel first described this linguiform projection of the liver, which is sometimes known as Riedel's lobe. It is said to be uniformly due to cholelithiasis, but that it is not always associated with gall-stones my experience in several cases demonstrates.

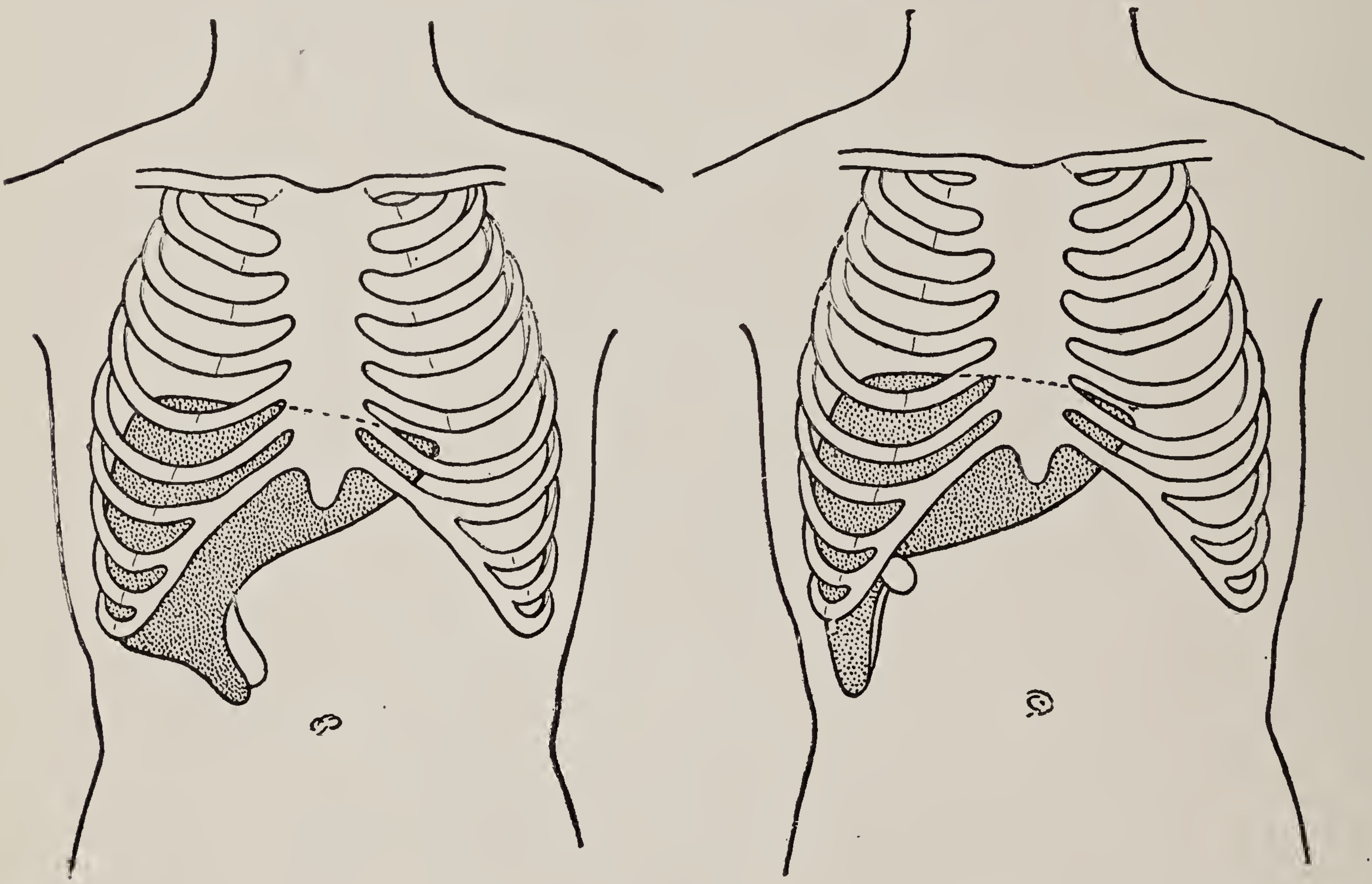


FIG. 114. DIAGRAMS TO SHOW VARIETIES OF THE LINGUIFORM PROCESS OF THE LIVER.

The liver is sometimes displaced vertically, as in one of my cases, where the incision had to be prolonged quite up to the ensiform cartilage in order to reach the shrunken gall-bladder, lying under cover of the right lobe, the under surface of which faced to the left side. In this case the left lobe was much smaller than the right, which formed the great bulk of the liver.

In one case the left lobe was apparently wanting, and the gall-bladder was deeply placed under the right lobe, which faced to the left.

There have been several cases reported where the distended gall-bladder projected into the loin, and was reached and evacuated through a lumbar incision, the condition of liver just described being the probable cause of the distortion.

Dr. J. F. Baldwin of Columbia, Ohio, has furnished me with the notes of a case that came under his care in which the liver was malformed, there being practically no left lobe, and the gall-bladder, instead of occupying the usual position on the under surface of the right lobe, passed downwards and backwards, and lay just to the right of the vertebral column, in which situation it was opened with difficulty for the removal of gall-stones, and drained. I have myself seen and operated on a similar case.

GENERAL REMARKS ON OPERATIONS FOR GALL-STONES

No surgeon should attempt the removal of gall-stones unless he is prepared for any of the various operations on the biliary passages, such as choledochotomy or cholecystectomy, as it is almost impossible to say beforehand what may be required until the ducts have been explored by the fingers and the condition of the affected viscera ascertained; and no operation should, as a rule, be concluded until it is clearly made out that the ducts, including the hepatic and common, are free from concretions, otherwise disappointment and dissatisfaction are certain to follow.

Since in the majority of cases, then, an operation for gall-stones is in the first place simply exploratory, the actual operation on the gall-bladder or bile ducts being only determined by the condition found when the abdomen is opened, it may be well first to consider a simple abdominal section in the gall-bladder region.

Preparation for operation. First, as to *the room* in which the operation has to be performed. Any ordinary well-cleaned room having high windows so as to give good top light answers almost as well as an operating theatre. There is, of course, an advantage in having an overhead electric light, but the operation now performed on the bile passages is, with few exceptions, done close to the surface, not as formerly at a great depth, which necessitated a special electric lamp, and always a very good vertical or high oblique light.

The advantage of operating in a hospital or surgical home is that the surgeon, or his house surgeon or assistant, is responsible not only for the operation but also for the after attendance, a matter almost as important as the operation itself. Moreover the surgeon can do his work better and with greater confidence where he is accustomed to operate, and where he is confident that all his directions before, at the time, and subsequently, will be carried out to the letter.

In this matter of where the operation should be done, the surgeon who has to do the operation ought to make the selection, and the patient should abide by the decision with the full confidence that the operator will select the place where he can do his work to the best advantage of the patient.

I have seen several unsatisfactory cases in which patients insisted on having operations performed in their own homes, which were utterly unsuitable for such a purpose, that would in all probability have done well had they been in a surgical home, where the complications causing the trouble could have had immediate and skilful attention.

The surgeon ought also to be helped by his ordinary *assistant* in all serious operations, for a stranger, no matter how skilled, can never accommodate himself immediately to the needs of the operator, and it must be remembered that surgery is a fine art, that can only be carried out with the greatest perfection under circumstances that are favourable to the operator.

The selection of the *anæsthetist* should also be with the operator, for with a competent anæsthetist the surgeon can devote the whole of his mind to his own part of the work in hand, without having his attention diverted to make suggestions concerning the anæsthetic.

With regard to *instruments,* a gall-stone scoop and curved clamps are the only special appliances required, and all the instruments are boiled for half an hour before being used.

My *sutures* and *ligatures* are of catgut prepared by the iodine process; they are strong and reliably aseptic. I have given up the use of silk sutures in gall-bladder surgery, and where a more durable stitch is required I employ 0 or 00 size of green chromic catgut, which answers equally well, as it does not become absorbed before the second or third week. As showing the disadvantage of non-absorbable sutures, there have been several cases recorded in which the knot of a ligature formed the nucleus of a gall-stone that had to be removed by operation, and one in which a silk suture used in a choledochotomy formed the nucleus of another gall-stone, which fortunately passed without further operation.

As *sponges,* sterilized gauze swabs are used, but for isolating the area of operation thicker swabs with a tape attached are employed. The area of operation is surrounded by dry sterilized towels or a perforated sheet, sterilized by superheated steam for half an hour.

My assistant and I wear boiled rubber *gloves,* and near the operating table I keep a bowl of 1 in 2,000 mercury biniodide solution or a normal saline solution in order to lave the gloved hands from time to time during the course of the operation. The instruments are used out of plain boiled water and the swabs are either used dry or wrung out of a hot normal saline solution. The ligatures and sutures are used out of a receptacle containing plain boiled water.

The patient is prepared by having an aperient given so as to secure the bowels being moved the day before operation, and an enema is given the evening before if the operation is to take place early the next morning. If there be any feebleness of pulse, 5 minims of liquor strychniæ are given subcutaneously on the afternoon and evening of the day before operation and 5 minims as soon as the operation is nearing completion. Should there be chronic jaundice or a tendency to hæmorrhage, calcium chloride is given; for although there is a greater tendency to bleeding in chronic jaundice from pancreatic disease than when jaundice is due to gall-stone obstruction, there can be no doubt that in all cholæmic conditions the blood becomes so altered that the coagulability becomes seriously diminished. Hence, in operating on deeply jaundiced patients, either an injection of normal serum should be given a few hours before operation, or chloride of calcium may be administered in two 30-grain doses by the mouth the day preceding operation, and afterwards in 30-grain doses by the rectum daily for two days, if needful.

The skin of the patient over the operation area is prepared the day before, by thoroughly washing with ether soap; if needful, shaving is then done. A dressing of lint, wet with 1 in 1,000 solution of biniodide of mercury in methylated spirit, is then applied, and over this oiled silk or gutta-percha tissue. The dressing is then changed early the next morning and the skin is thoroughly washed, so as to clear away all loose and sodden epithelium, after which another dressing is applied, to be removed on the operating table.

If the patient be feeble, a pint of normal saline solution with an ounce of brandy is given *per rectum* a short time before the operation.

As shock is intensified by exposure to cold, my patients are always enveloped in cotton-wool, which is conveniently done by making a suit of gamgee tissue that can be readily run together by the nurses in an hour or two the day before operation.

It will be found that a firm sand-bag, about 18 inches long by 6 inches wide and 3½ inches deep, warmed and covered with flannel, and placed on the operating table at the liver level, will push the spine forward, and with it the liver and bile ducts, so that the common and hepatic ducts are brought several inches nearer the surface. By opening out the costal angle and tending to make the intestines slip down from the liver, it acts like the Trendelenburg position in pelvic surgery.

An inflatable rubber bag may be employed in place of the sand-bag if preferred, or a firm roll of towels will answer if other appliances are not at hand.

Though this method, until I drew attention to it, does not seem to have been employed by others, I can from ample experience speak well of its great utility. Instead of the sand-bag, I have, during the past two or three years, been employing a table, which by a slight mechanical act elevates the hepatic region with facility, and this without disturbing the patient or deranging the aseptic surroundings.

Operation. Whereas I used formerly to make a vertical incision through the linea semilunaris, I now always make my incision over the middle of the right rectus in a line parallel with its fibres, which are then separated by the finger, the posterior sheath of the rectus and peritoneum being divided together. Where the gall-bladder is distended and there is no jaundice, a small incision of 2 or 3 inches only may be required; but when it is necessary to explore either hepatic, common, or deeper part of the cystic duct, instead of prolonging the incision downwards as was formerly done, I now carry it upwards obliquely as high as possible in the interval between the ensiform cartilage and the right costal margin, thus freely exposing the upper surface of the liver. In some cases I have displaced the rectus inwards or outwards instead of splitting the fibres, as in the operation for removing the appendix. It will be found that by lifting and rotating the lower border of the liver (if needful first drawing the organ downwards from under cover of the ribs) the whole of the gall-bladder and the cystic and common ducts are brought quite close to the surface, and as the gall-bladder is usually

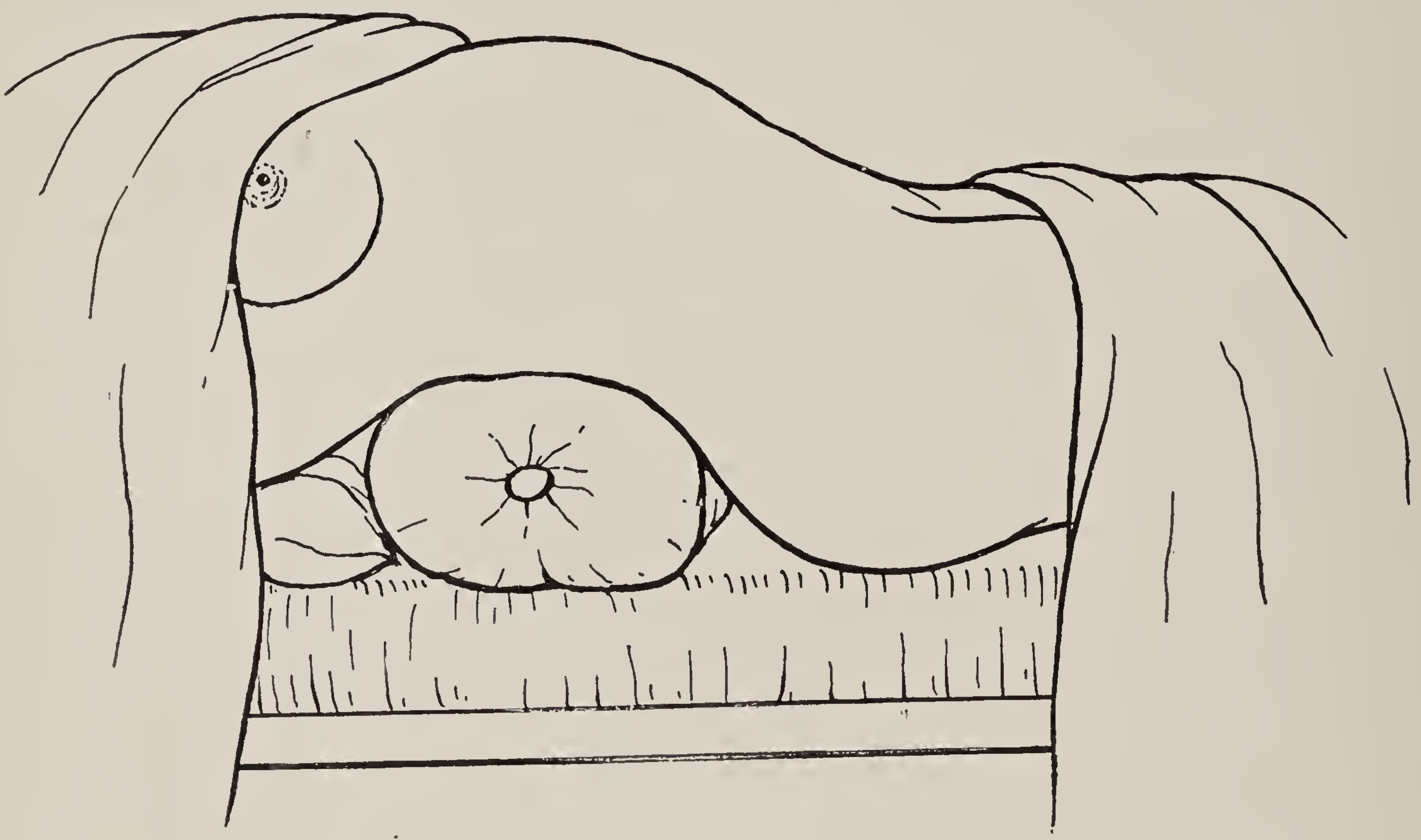


FIG. 115. DIAGRAM TO SHOW SAND-BAG OR CUSHION PLACED UNDER THE BACK TO RENDER PROMINENT THE LIVER AND BILE DUCTS.

strong enough, an assistant can take hold of it with his fingers or forceps and by gentle traction can keep the parts well exposed, at the same time that, by means of his left hand with a large moist swab under it, he retracts the left side of the wound and the viscera, which would otherwise fall over the common duct and impede the view.

It will now be observed that, instead of the gall-bladder and cystic duct making a considerable angle with the common duct, an almost straight passage is found from the fundus of the gall-bladder to the entrance of the bile duct into the duodenum, and if adhesions have been thoroughly separated, the surgeon has immediately under his eye the whole length of the ducts with the head of the pancreas and duodenum. So complete is the exposure that, if needful, the peritoneum can be incised over the free border of the lesser omentum and the common duct separated from the hepatic artery and portal vein, though this is not necessary except where a growth has to be excised. The surgeon, whose hands are both free, can now deal with the gall-bladder and cystic, common, and hepatic ducts quite easily, and it is safe to affirm that there is no portion of the gall-bladder and cystic, common, or primary division of the hepatic ducts which cannot under ordinary circumstances be reached for the removal of concretions.

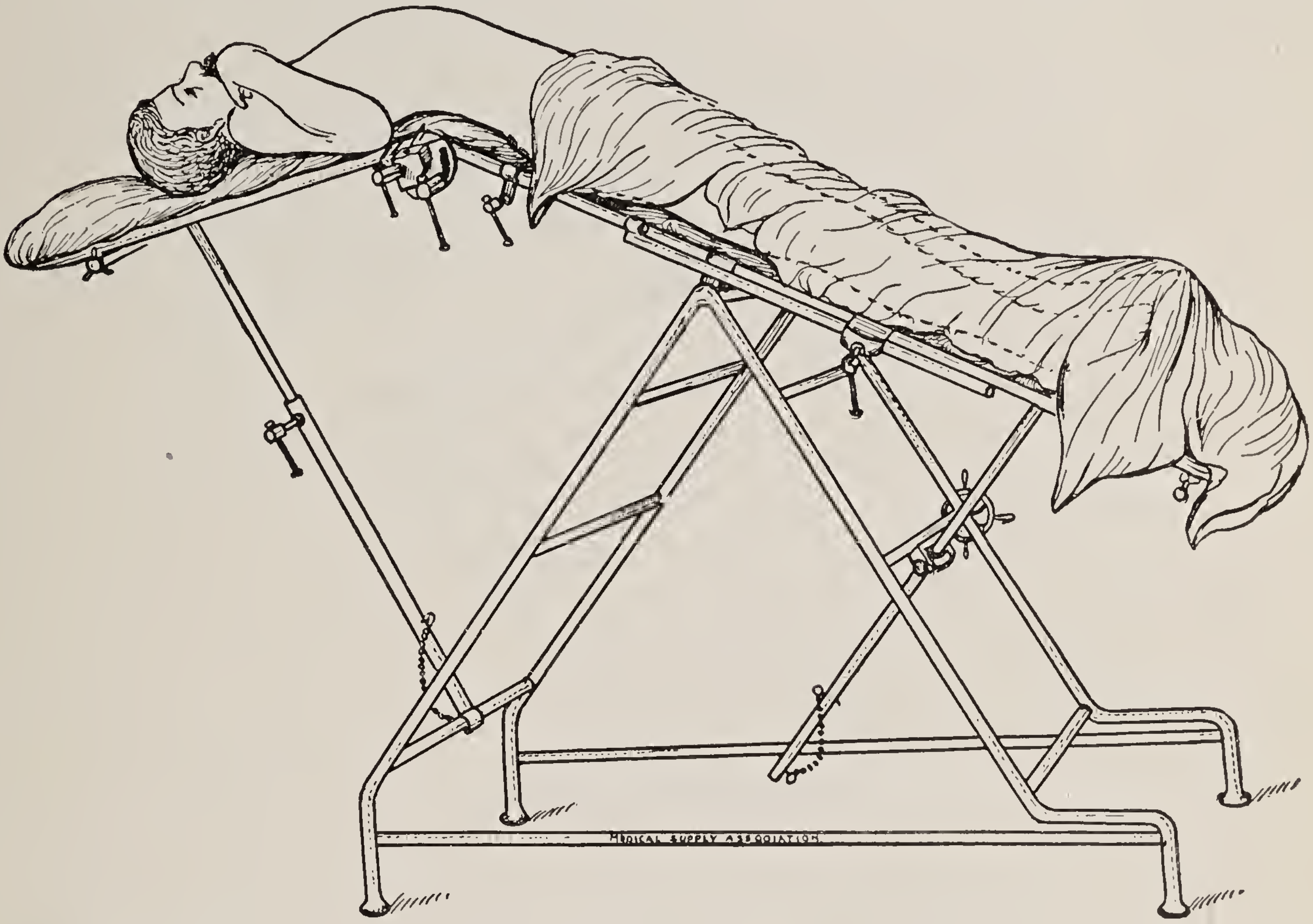


FIG. 116. DIAGRAM TO SHOW THE TABLE EMPLOYED BY THE AUTHOR FOR ELEVATING THE HEPATIC REGION.

Although there is seldom any fear of leakage or of infection, yet, where the ducts have been incised and extensive adhesions separated, there usually is some tendency to pouring out of fluid in the first few hours. I therefore generally insert a gauze drain through a drainage tube passed into the right kidney pouch, bringing it out through a stab puncture 3 or 4 inches away from the chief incision, towards the right loin; thus dependent drainage is obtained and the anterior incision can be securely closed. This drain is usually removed within forty-eight hours (see Fig. 127, p. 290).

The wound is closed by continuous catgut sutures, first to peritoneum and deep rectus sheath, and next to the anterior rectus sheath. Lastly, the skin margins are brought together by means of two or three interrupted silkworm-gut sutures inserted quite an inch from the line of incision, taking up the anterior rectus sheath and being brought out an inch beyond the incision on the other side so as to allow the edges to fall together without tension, the skin between the sutures being accurately brought together by Michel's metal clips, thus securing union by first intention.

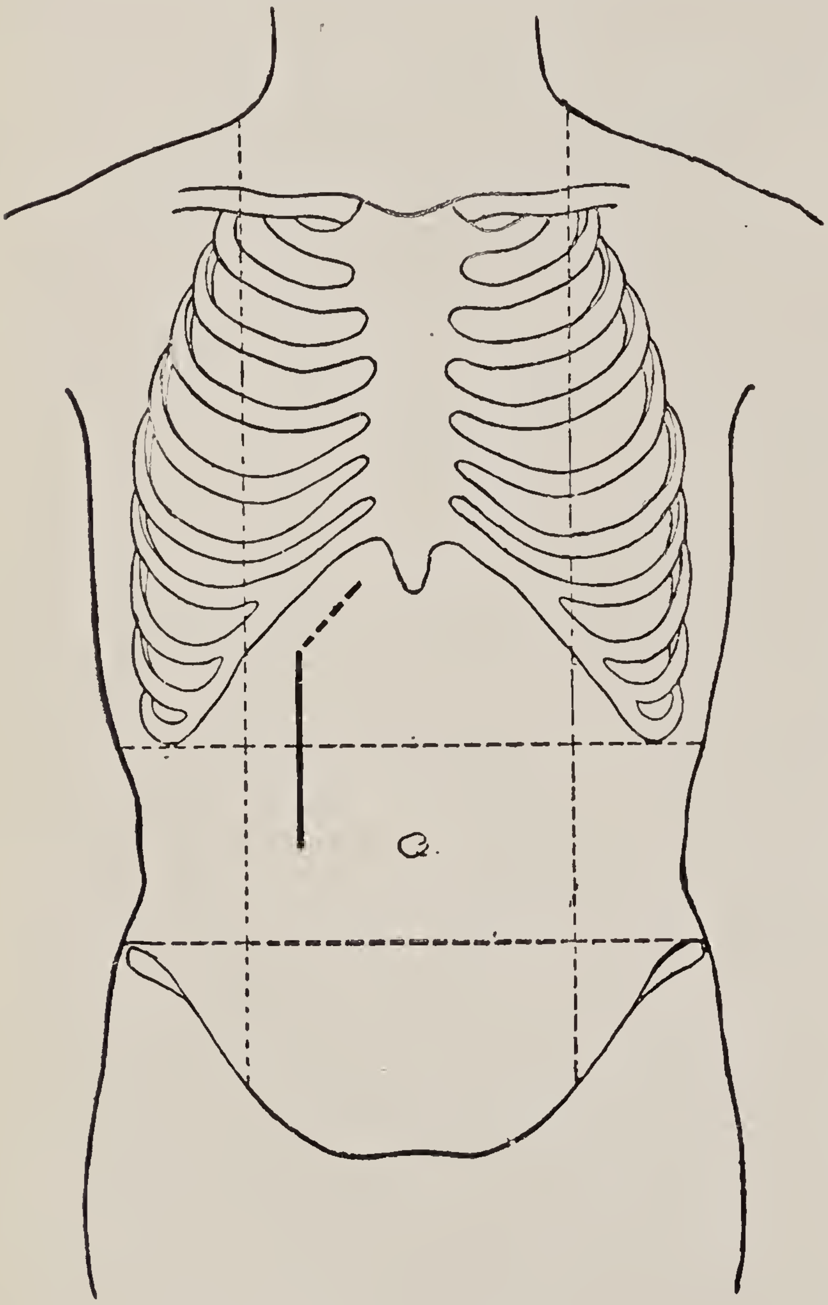


Fig. 117. Diagram to show the usual Incision employed by the Author. The dotted line shows the direction in which the incision may be conveniently extended when it is necessary to expose the common duct.

If the wound is a large one or the patient is feeble or has a cough, or if there is any fear that the edges of the tissues have been contaminated by the infected bile, the two or three silkworm sutures above referred to, instead of simply taking up the skin and superficial structures only, are made to transfix all the tissues; but these do not in any way alter the arrangements of the continuous catgut suture.

To those having little experience in these operations, the modifications I have employed may seem trivial, but by those who have experienced the difficulties of the ordinary operation of removing gall-stones from a contracted gall-bladder, or from the cystic or common ducts, I feel sure the method described, which enables the whole of the bile passages to be dealt with as a straight line close to the surface, will be sufficiently appreciated.

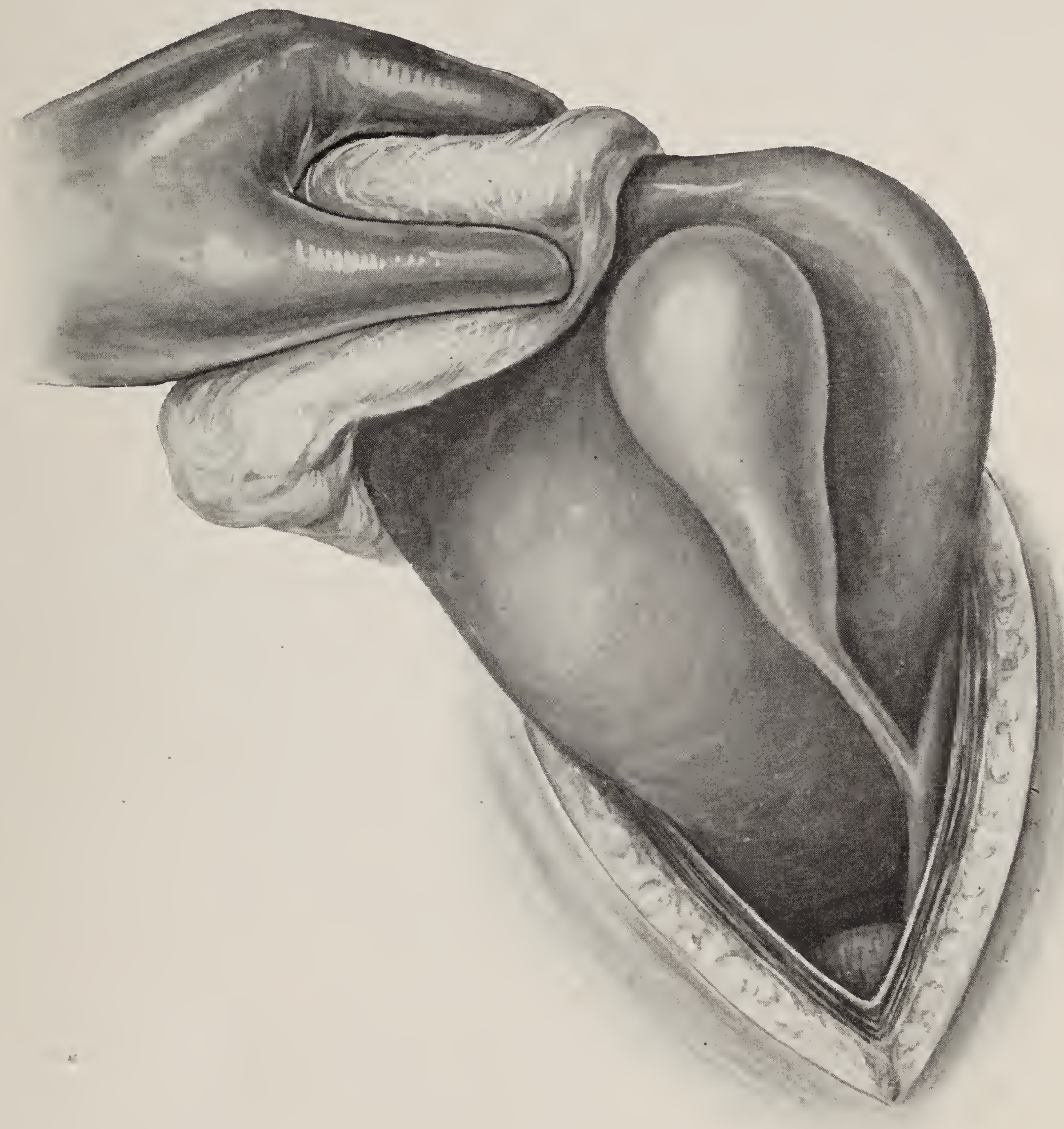


FIG. 118. DIAGRAM TO SHOW THE AUTHOR'S METHOD OF COMPLETELY EXPOSING THE GALL-BLADDER AND BILE DUCTS.

In these operations, forcipressure is employed for the immediate arrest of hæmorrhage, but I find it is more satisfactory also to ligature all bleeding points, as in jaundiced cases the compressed and unligatured vessels are apt to bleed subsequently and to lead to complications that are avoidable by careful hæmostasis. For the same reason, I prefer to divide and ligature firm, visceral, especially hepatic, adhesions, where this is practicable, rather than as formerly to separate them with the finger or tear them through.

If the liver be torn in separating adhesions, the bleeding must be carefully arrested before the abdomen is closed. Sponge pressure is usually sufficient if the laceration be small, but if the laceration be extensive, deep catgut sutures applied by means of a round intestinal needle will usually accomplish the desired effect; or, this failing, gauze pressure is employed, the plug being left in until it becomes loose.

After-treatment. Expedition in operation is an important factor in lessening shock, especially in abdominal surgery, for it stands to reason that prolonged manipulation and exposure of the viscera, in patients so ill as the class of cases we are now considering must generally be, will be badly borne; for it is not only the work of the surgeon but the deep anæsthesia that adds to the shock, since for these operations to be expeditiously performed the muscles must be well relaxed. Choledochotomy should occupy from half an hour to an hour, and only in case of unusual complications a little longer.

After operation, a pint of saline fluid with 1 ounce of brandy is given by enema, and 5 minims of liq. strychniæ are given subcutaneously, this being repeated if called for. Subcutaneous injections of saline fluid or intravenous infusion are only rarely required. The saline enema, with an ounce of liquid peptonoids and an ounce of brandy, is repeated in two hours and again in four hours.

Beyond a teaspoonful of hot water or hot tea or albumen water from time to time, all feeding is by the rectum for the first twenty-four hours, though if there be no vomiting the teaspoonful of water is increased to a tablespoonful, or even two, every hour or oftener. After forty-eight hours, if there be no vomiting, milk and soda and barley-water can be freely given. A little plasmon dissolved in the tea or beef-tea or barley-water considerably adds to the nutritive value of the fluid. Light custard pudding is usually given on the third or fourth day, fish on the fifth, and chicken on the sixth, after which the diet becomes almost normal.

The bowels are not disturbed before the fifth or sixth day, and then only by enema, unless there is vomiting or distension, and in case of either of these complications a grain of calomel is administered and followed by 2 ounces of apenta water every two hours until it acts or flatus passes freely, this being helped by the rectal tube or by a turpentine enema or by a soap and water enema containing 10 minims of oil of cajuput.

Morphine is avoided after all my abdominal operations, as it tends to paralyse the intestines and leads to an accumulation of flatus. I believe that abstention from the use of morphine is a great feature in the success of abdominal surgery, just as I feel that in the past it has killed many patients who would otherwise have done well.

If a sedative be needed, 5 or 10 grains of aspirin will be found useful, and this can be repeated in two hours if required. In case of vomiting being troublesome or epigastric distension persisting, gastric lavage will be found useful, and when the stomach is emptied, a dose of apenta water may be left in it to incite peristalsis. Under these circumstances no food or fluid is allowed by the mouth, but plenty of fluid in the shape of normal saline is given by rectum.

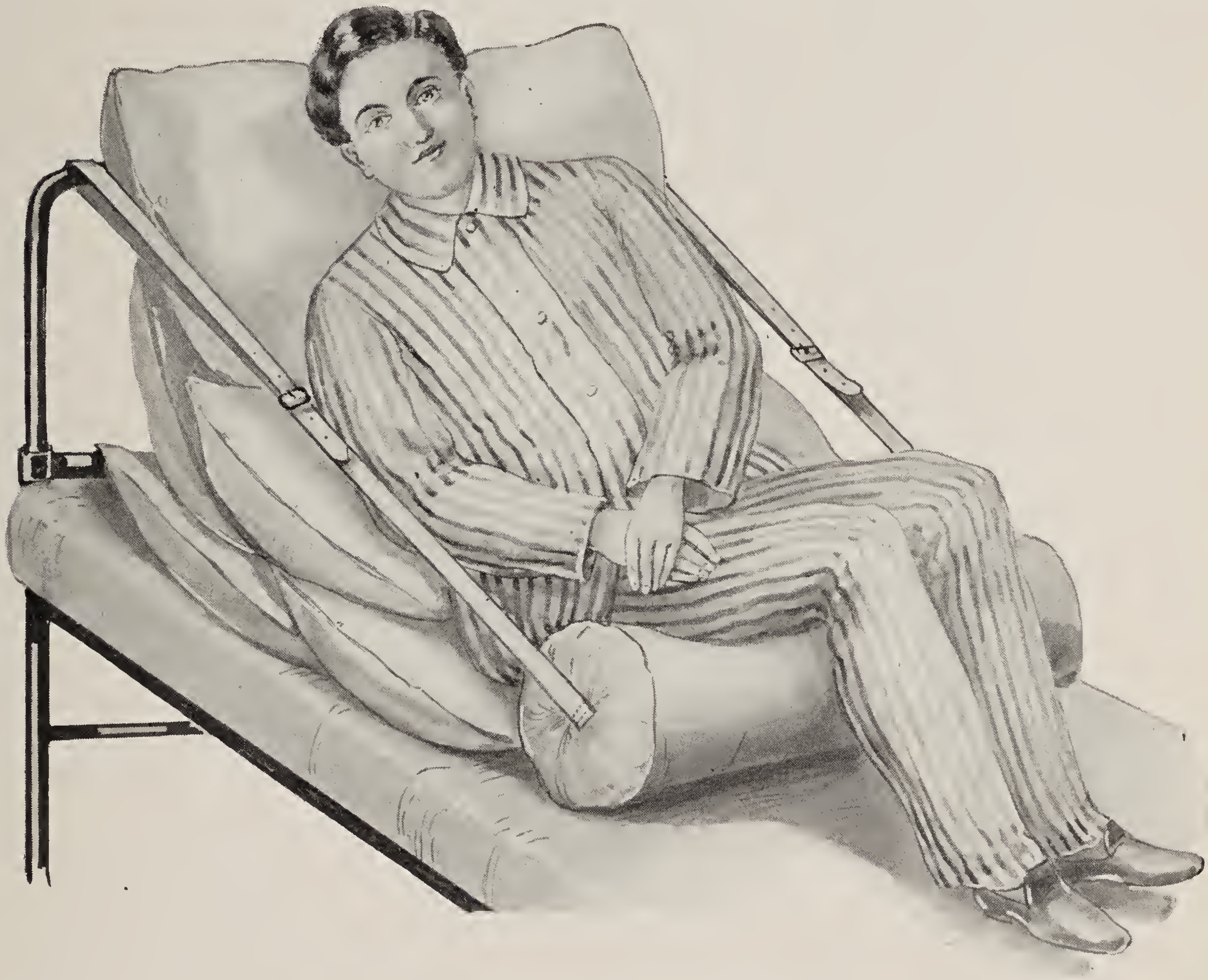


FIG. 119. THE SLING PILLOW.

After all my abdominal operations I am accustomed to place the patient in the position shown in the accompanying drawing. It not only is a comfort to the patient immediately after operation, but prevents lung complications and in the later stages shortens the time of convalescence. The sling pillow, which was invented by Mr. J. A. C. Forsyth, renders it easy to retain the patient in position (see Fig. 119).

As a rule recovery is uneventful, and for the most part after-treatment is negative. The stitches are removed on the eighth day and the tube usually comes away about the same time; the wound generally will have healed by first intention, and the spot where the tube was heals by granulation. The dressings are of the simplest—sterilized gauze and sterilized cotton-wool being employed as a rule, double cyanide gauze being sometimes used next to the wound.

OPERATIONS FOR PERFORATION OR RUPTURE OF THE GALL-BLADDER OR BILE DUCTS

Operation in perforation from disease. If, unfortunately, in inflammation of the gall-bladder or bile ducts the disease be allowed to progress to rupture before surgical treatment is adopted, as soon as it is clearly made out that perforation has occurred, or even if it be only suspected that such is the case, the abdomen should be opened by a vertical incision through the right rectus above the umbilicus.

If pus and bile be found they should be rapidly wiped away with gauze swabs, and if the extravasation has become general, the abdomen may be flushed with hot sterilized saline solution.

In draining, it should be borne in mind that the right kidney pouch (see Fig. 127) forms a distinct peritoneal pocket, and that a drainage tube applied through a stab opening in the right loin affords a free exit for extravasated fluids coming from the neighbourhood of the gall-bladder. If the whole peritoneal cavity has been soiled, a puncture above the pubes large enough for a tube to be passed into the pouch of Douglas will be an advantage.

At the same time it will be wise to drain the gall-bladder or bile ducts either through the perforation or through a separate cholecystotomy opening, but should marked cholecystitis be found, the question of performing cholecystectomy may have to be considered if the patient be in a condition to bear the operation. If, however, the patient be in a critical condition it is a mistake to attempt too much, and possibly cleansing and free drainage will only be necessary or advisable at the time, the removal of the cause being left until the patient is better able to bear a more prolonged operation.

After operation the patient must be propped up in bed or turned to the right side to allow of dependent drainage.

Operation for injury. *In the case of penetrating wounds*—if seen early—immediate operation is called for in order to repair the injury and drain the right kidney pouch. In case of laceration of the gall-bladder, cholecystotomy or cholecystectomy is advisable, according to the extent and nature of the laceration.

If the common duct be lacerated, suture may be possible, or failing that, a drainage tube may be inserted into the duct. In complete rupture of the common duct, Terrier has suggested ligature of both ends of the laceration and the performance of cholecystenterostomy.

In case of laceration of the hepatic duct, suture may be impracticable and drainage of the duct only possible, but whether or not suture can be performed, the right kidney pouch must be drained through a stab wound in the right loin.

In subcutaneous rupture without external wound, if the diagnosis be made early, and in all cases where the bile is infected, exploratory laparotomy with free drainage of the right kidney pouch is imperative. If the whole peritoneal cavity has been soiled, a glass tube should also be passed through a stab wound over the pubes so as to drain Douglas's pouch, and the patient should then be fully propped up in bed; this position being retained by the sling pillow shown in Fig. 119.

If the operation be performed before adhesions have developed, the injury should be repaired, but if adhesions have formed and extravasation is limited to the right side, free drainage of the right kidney pouch and right-sided decubitus should alone be adopted, leaving the closure of the wounds to nature's efforts.

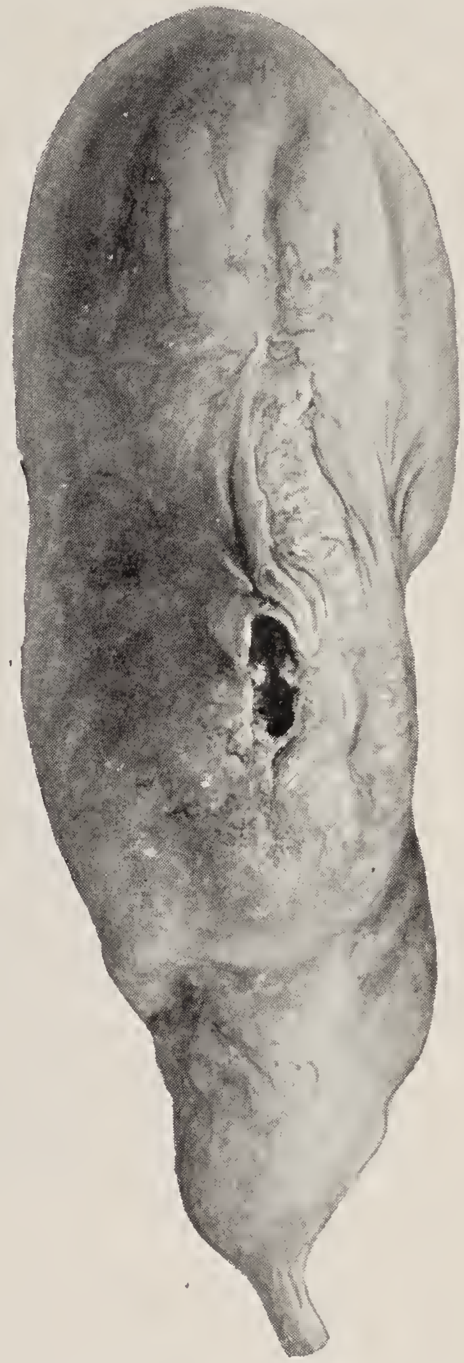


Fig. 120. Laceration of the Gall-bladder. Drawing of Specimen No. 2267, St. Bartholomew's Museum. Showing a laceration ¾ inch long in a gall-bladder previously dilated as the result of a gall-stone lodging at the entrance to the cystic duct. The specimen is from a man of fifty who was kicked when stooping.

Secondary laparotomy will usually be called for in cases of subcutaneous rupture, owing to the difficulties in diagnosis until jaundice appears. In many cases it will be impossible to detect the wound owing to the formation of false membrane. In these cases the bile may be washed out with saline solution and the abdomen drained, or simple drainage without lavage may suffice.

If a small wound be found in the gall-bladder, it may be sutured or the gall-bladder may be drained through the opening. If the gall-bladder be extensively lacerated, or if the cystic duct be injured, cholecystectomy should be performed.

Terrier collected twelve cases of secondary laparotomy for injuries to the bile ducts and gall-bladder with six recoveries.

Aspiration alone has been frequently successful where a diagnosis had not been made until the extravasated bile had been shut off by lymph barriers from the general peritoneal cavity.

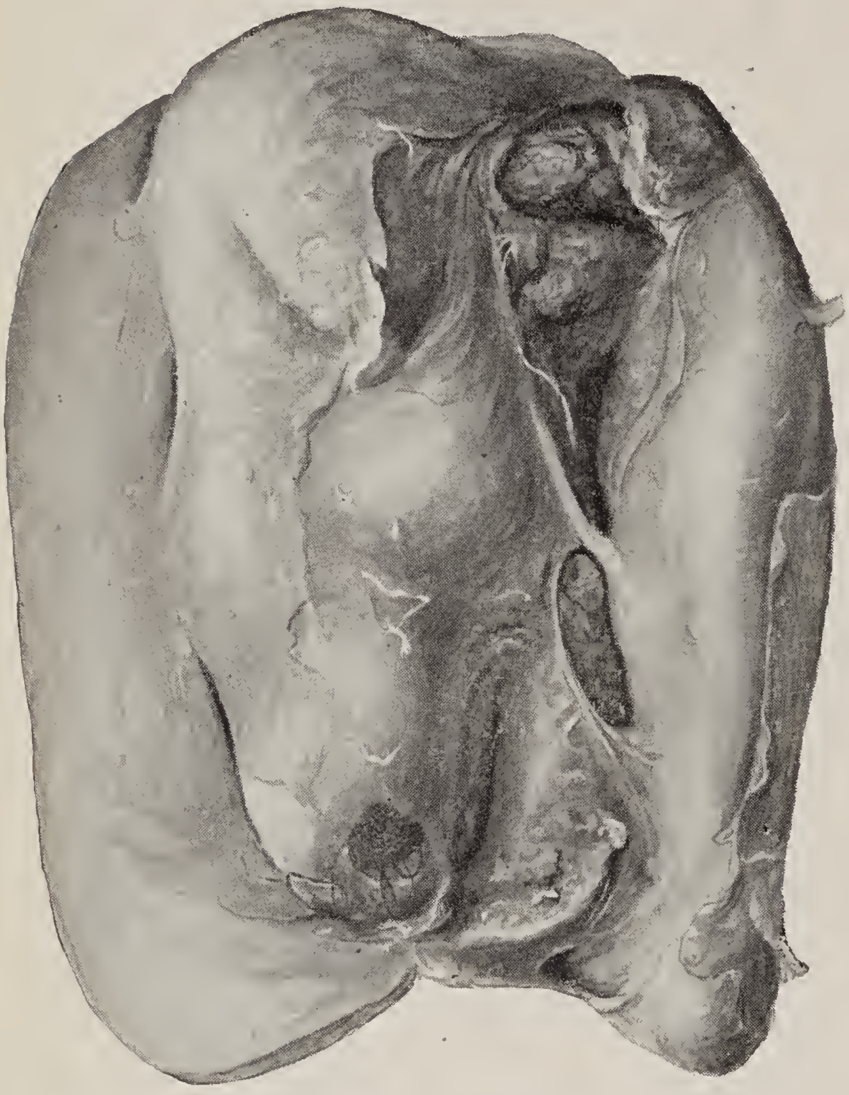


Fig. 121. Rupture of the Gall-bladder. Drawing of Specimen No. 2268, St. Bartholomew's Museum. Showing a rupture of the fundus of the gall-bladder caused by a fall on a piece of timber. Bile escaped into the peritoneum and death from peritonitis followed after five weeks.

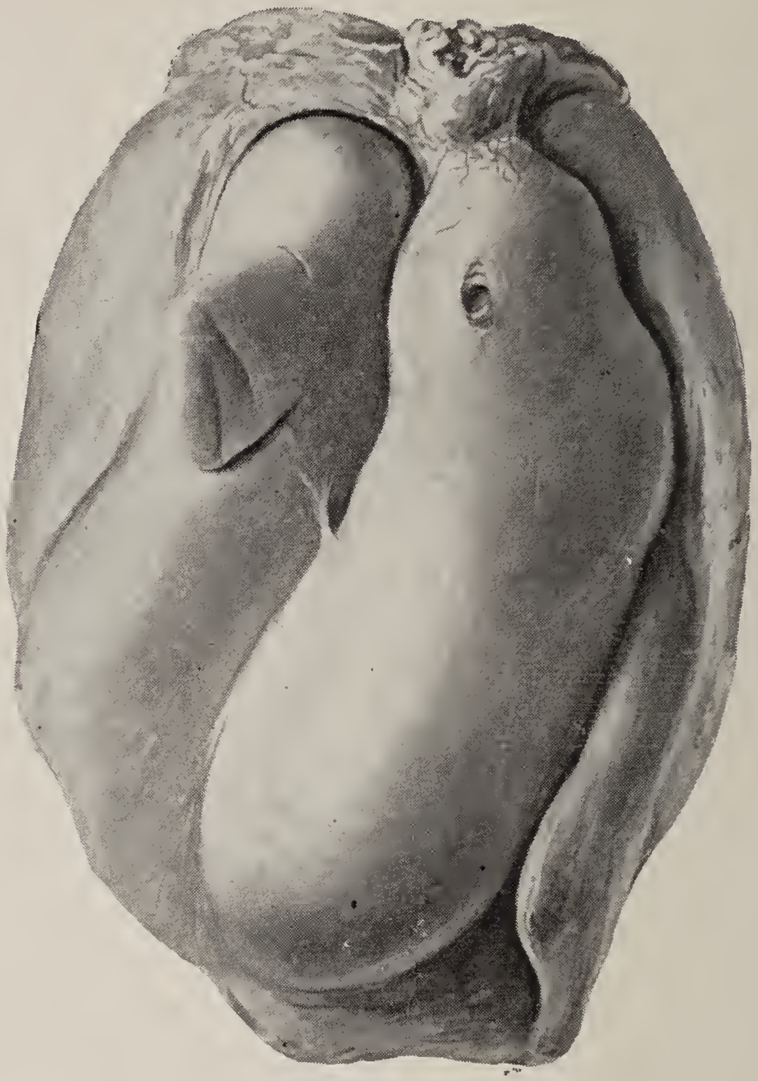


Fig. 122. Perforation of the Gall-bladder. Drawing of Specimen No. 2268 a, from St. Bartholomew's Museum. Showing a perforating wound of the gall-bladder from a boy of fifteen who fell from a load of hay on to a pitchfork. Death occurred after five days from peritonitis with extravasation of bile.

Courvoisier collected eighteen cases of aspiration, with recovery in eleven. He advocated repeated aspiration before resort to laparotomy.

Terrier and Auvray (*Chirurgie du Foie*) collected seventeen cases in which aspiration (in most cases repeated) had been performed. Of these, ten recovered and seven died.

Occasionally a single aspiration has been successful; more usually multiple aspirations are required before recovery ensues.

CHAPTER II

OPERATIONS UPON THE GALL-BLADDER

CHOLECYSTOTOMY

The term cholecystotomy is applied to the ordinary operation of opening and draining the gall-bladder. It is available for many of the diseases affecting the liver, pancreas, gall-bladder, and bile ducts, and is unquestionably *the* operation to be aimed at in the greater number of cases of cholelithiasis, the operation of cholecystectomy being reserved only for the special conditions mentioned later.

Indications. Cholecystotomy is indicated—

(i) In operating for gall-stones in the gall-bladder, when it has sufficient capacity to permit of drainage and is otherwise not seriously damaged.

(ii) In operating for gall-stones in the cystic duct if the duct be free from ulceration and is not strictured.

(iii) In operating for gall-stones in the common duct after the removal of the concretions by choledochotomy, if the gall-bladder be not seriously diseased and the cystic duct is patent and not ulcerated.

(iv) In chronic catarrh of the gall-bladder and bile ducts producing attacks resembling gall-stones, after failure of general treatment.

(v) In simple empyema of the gall-bladder, when the walls of the gall-bladder are not seriously damaged.

(vi) In infective and suppurative cholangitis, after removal of the cause, if that be possible.

(vii) In hydatid disease of the liver discharging into the ducts, cholecystotomy will be a necessary part of the operation.

(viii) In hydrops of the gall-bladder, if the gall-bladder be only of moderate size, if the obstructing cause be capable of removal, and if the cystic duct be not ulcerated or strictured.

(ix) In certain cases of jaundice due to inflammation of the head of the pancreas compressing the bile duct, where it is not considered necessary or advisable to perform cholecystenterostomy.

(x) In cancer of the common duct or of the head of the pancreas obstructing the common duct and setting up jaundice, it may occasionally be justifiable to perform cholecystotomy for temporary relief:

though if it can be done quickly and the patient is able to bear it, cholecystenterostomy is the better operation.

(xi) In rupture or perforation of the biliary passages from injury or disease, cholecystotomy may be advisable along with other remedial measures.

(xii) In gangrene of the gall-bladder or phlegmonous cholecystitis, only when the patient is so extremely ill that no other operation can be attempted.

(xiii) In infective inflammations of the gall-bladder, as in typhoid fever.

The operation is contra-indicated—

(i) As a rule in gangrenous or phlegmonous cholecystitis, unless the patient be so extremely ill that cholecystectomy cannot be undertaken.

(ii) In case of stricture or ulceration of the cystic duct, in which cholecystectomy is indicated.

(iii) In case of stricture or other obstruction of the common duct which it is impossible or impracticable to remove, when cholecystenterostomy is indicated.

(iv) In greatly dilated, or so-called hydrops of the gall-bladder, cholecystectomy is indicated.

(v) In contracted, thickened, ulcerated, or other seriously diseased conditions of the gall-bladder, when cholecystectomy should be performed if the common duct be patent.

(vi) In cancer or other growth of the gall-bladder or cystic duct.

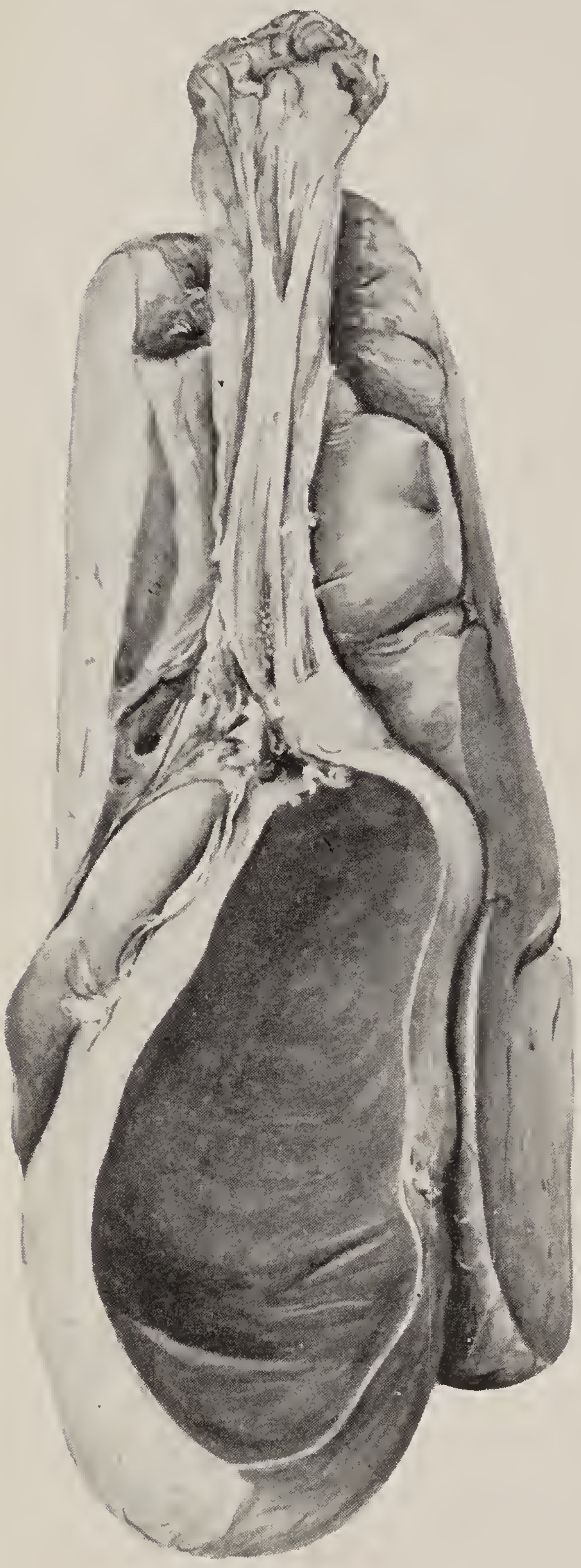


Fig. 123. Inflammation of the Gall-bladder and Bile Ducts in Typhoid Fever. Death in the seventh week. (*No.* 1395, *Guy's Museum.*)

Operation. Nothing can be simpler than an ordinary cholecystotomy with a distended gall-bladder, or even with a gall-bladder of ordinary size, where a small incision suffices to expose the sac, which is emptied by a trochar or aspirator. The collapsed sac is then brought through the wound and surrounded by sterilized gauze. It is then incised through the point where the needle was inserted, and through the wound in the fundus the gall-stone scoop is inserted, and all gall-stones are removed, a probe or the finger being employed to prove the ducts clear. A firm rubber tube, much firmer than the drainage tubes ordinarily sold, is then inserted from ½ to 1 inch into the gall-bladder, the edges of the incision into the gall-bladder being drawn firmly around it by a catgut purse-string suture, which is tied and cut short, the tube being fixed in position by a fine (size 0) non-chromic, catgut suture, which transfixes the tube and the edges of the incision in the gall-bladder. The gall-bladder is then fixed to the aponeurosis by two catgut stitches, but never to the skin unless a permanent biliary fistula is intended. This tube is sufficiently long to pass into a bottle by the side of the patient; it drains all the bile away from the wound, and by the time the catgut has dissolved, usually on the seventh or eighth day, the wound will have healed by first intention, except where the tube was, and that heals by granulation within the next week or two if the ducts are clear.

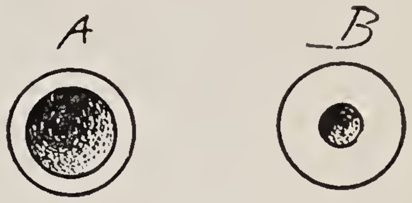


FIG. 124. DIAGRAM TO SHOW THE THICK-WALLED TUBE USED BY THE AUTHOR. A shows the ordinary drainage tube; B shows the thick-walled tube.

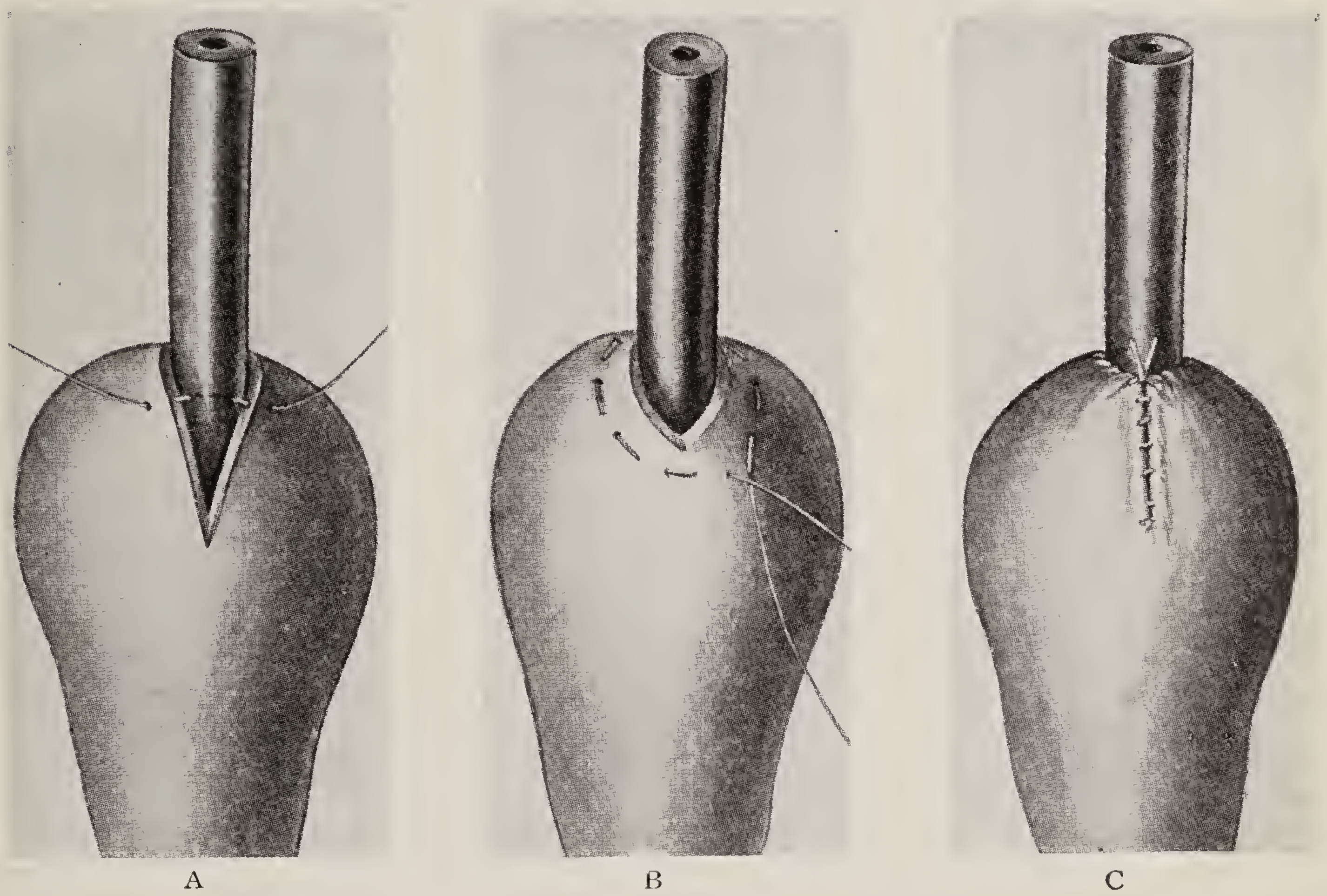


FIG. 125. DIAGRAMS TO SHOW THE METHOD OF FIXING THE DRAINAGE TUBE IN THE GALL-BLADDER AFTER THE OPERATION OF CHOLECYSTOTOMY.

This description applies only to operations on a gall-bladder of normal size or to one that is distended, a condition met with in only a proportion of cases in which operation is undertaken for gall-stones. When the gall-bladder is small and situated deeply, or the liver is retracted beneath the costal margin, or when both the gall-bladder and bile ducts are covered in by adherent, possibly distended viscera, and the patient has a considerable development of fat both within the abdomen and beneath the skin, the surgeon must be prepared to face a more difficult operation.

In such cases the modifications described on p. 276 will be found of the greatest service. The position is obtained either by means of a sand-bag or of a special table, and the incision extended upwards obliquely to the notch on the right of the ensiform cartilage will have been employed and the abdomen opened.

Adhesions must now be separated, and in the case of old omental adhesions to the liver it is safer to ligature them *en masse* or bit by bit, as otherwise bleeding is apt to be troublesome from the torn liver surface.

All vessels must be caught up and ligatured, otherwise blood will collect and obscure the field. The viscera must be handled gently, and in the case of firm and close adhesions between the gall-blader and colon or duodenum or pylorus, if they do not readily separate by wiping with gauze, it is better to associate digital manipulation with careful dissection until a clear view is obtained of the gall-bladder and cystic and common ducts.

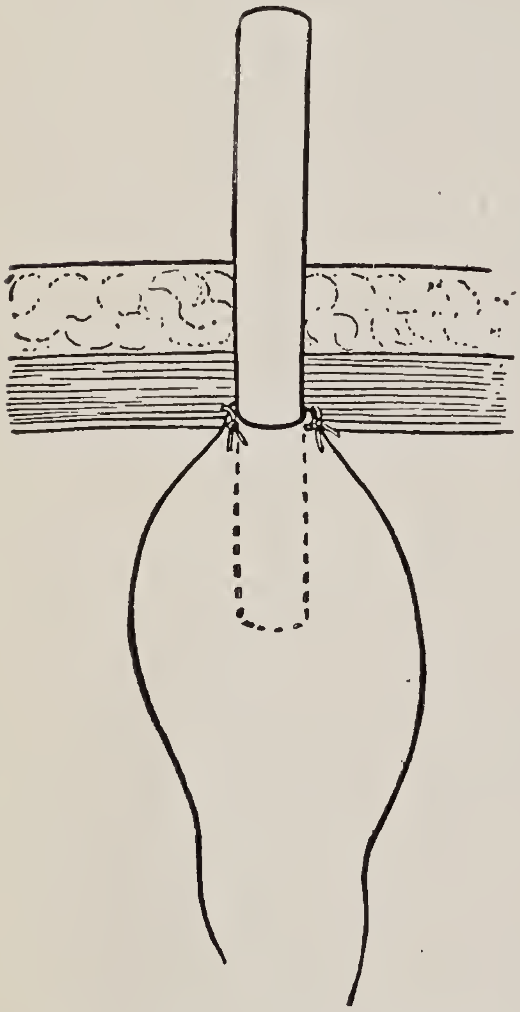


FIG. 126. FIXATION OF THE GALL-BLADDER TO THE ABDOMINAL APONEUROSIS.

If the liver be of normal size and the adhesions have been detached, or if the right lobe be enlarged, as is so often the case in gall-stone disease, the assistant can easily grasp the free border between his fingers, or take hold of the gall-bladder and draw it forward, thus rotating the liver and bringing the gall-bladder and bile passages well within view (see Fig. 118).

A sterilized gauze swab wrung out of hot normal saline solution is then placed in the wound over the exposed viscera, the gall-bladder being packed off. The edges of the skin and the abdominal wound are also covered with gauze to avoid soiling. The gall-bladder is then emptied of fluid, if any be present, by means of an aspirator or trochar, great care being taken to avoid escape of fluid which may be septic.

Through the point of the aspirator puncture the gall-bladder is incised, the wound being enlarged sufficiently for the gall-stone scoop to be introduced, and by its means all gall-stones are removed from the gall-bladder and cystic duct, their removal being assisted, if necessary, by the index and middle fingers of the right hand being passed behind the swab so as to press on the cystic duct to extrude any deeply placed concretion.

If a gall-stone be impacted in the cystic duct and cannot be manipulated backwards, the duct, which should be close to the surface if the liver is rotated, must be incised and the stone extracted. A probe can then be passed upwards and downwards in order to ascertain if the gall-bladder and cystic duct are free; and if the latter be free from ulceration and be not strictured, it may be closed by a No. 1 catgut suture to the deeper part of the duct and a No. 0 chromic catgut suture to the peritoneal surface; or, if preferred, interrupted sutures may be employed to close the duct. After exploring the common and hepatic ducts to see that no other calculi are present, a thick-walled drainage tube—for instance, a No. 12 Jaques's rubber catheter—is inserted about half an inch into the gall-bladder through the incision, which is either closed around the tube by means of a purse-string suture of No. 1 catgut, or by interrupted sutures (see Fig. 125, B and C). After the tube has been fixed in by a single suture passing through its wall and through the edge of the gall-bladder incision (see Fig. 126), the liver is allowed to fall back into its normal position, and in case of any soiling of the peritoneum it is wiped out with a swab wet with normal saline solution. The gauze swab covering the viscera may now be removed and replaced by a clean one.

If the gall-bladder be of moderate size it will reach the parietes and be fixed to the deep aponeurosis by two sutures as described in a simple operation, but if it be small or contracted it will not reach the parietes; in that case the right border of the omentum may be fixed to the gall-bladder by a suture or two so as to make a peritoneal channel to the surface when the tube comes away about the seventh day. This method, which I described some years ago, I have adopted on many occasions with success.

If, however, this should not be practicable, no harm will occur if the incision in the gall-bladder tightly embraces the drainage tube, as adhesions will form within twenty-four or forty-eight hours that will offer an effectual barrier to the escape of bile into the general cavity of the peritoneum. The tube may then be brought out through the primary incision, which is closed around it as described on p. 287.

For some time I have adopted the method of bringing out the tube through a stab wound external to the primary abdominal incision, if there has been any soiling of the right kidney pouch such as to necessitate the use of a drain. The drainage tube or gauze drain is then brought out by the side of the gall-bladder tube, it being changed within twenty-four hours and usually removed within forty-eight hours.

By adopting this method, the primary incision is able to be closed, and healing by first intention ensured, whereas when the double drain is passed through the wound, infection is likely to occur, involving delayed healing and a weak scar.

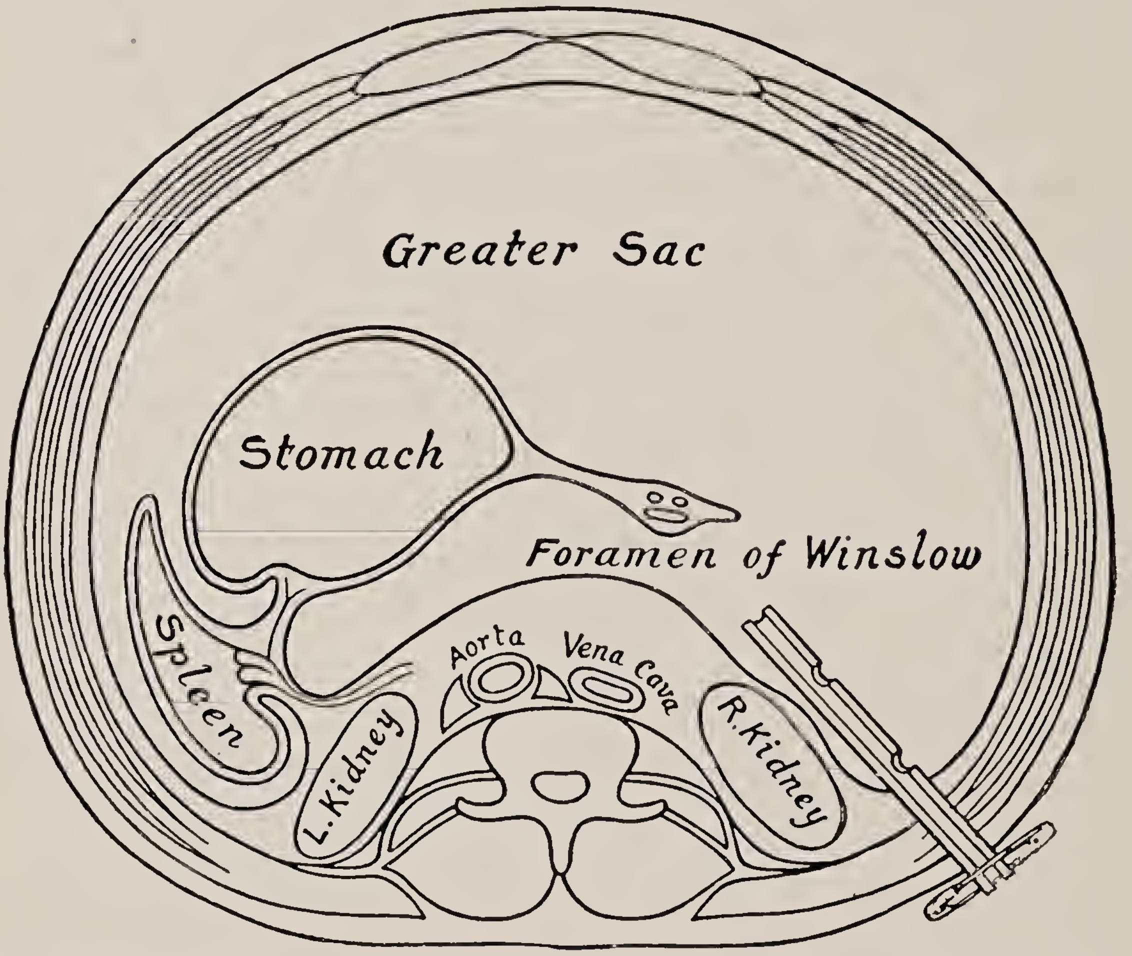


FIG. 127. DIAGRAM TO SHOW THE RIGHT KIDNEY POUCH WITH A DRAINAGE TUBE INSERTED THROUGH A STAB WOUND.

Modifications. The operation of cholecystotomy has been modified in several ways; for instance, the opening has been closed by sutures and then fixed to the abdominal incision without drainage, the abdominal incision being closed over it. This is known as *cholecystendysis* (Courvoisier).

Langenbuch suggested the so-called *ideal operation*, in which the incision into the gall-bladder is closed by mucous and serous sutures and the viscus dropped back into the abdomen. The serious objection to this operation is that the benefits of drainage are not obtained as in the ordinary operation of cholecystotomy, for it should not be lost sight of that gall-stones are always associated with catarrh or more active inflammation of the bile passages which is cured by drainage. Another serious objection to this method is that it is decidedly more dangerous than the ordinary operation.

Another modification suggested by Bloch is that *in two stages.* The operation consists in incising the parietes until the peritoneum is reached, the cavity of which, however, is not opened; the wound is then packed with gauze and left for several days, when adhesions will have formed between the gall-bladder and the parietal peritoneum. The gall-bladder can then be safely opened. Or if the peritoneum be incised, the gall-bladder is fixed, but not opened until adhesions have formed.

As the method is only available for the simplest cases, viz. where the gall-bladder is distended, as it does away with all chance of exploring the ducts by the hand within the abdomen, and as it is frequently followed by fistula, it needs only to be mentioned to be condemned as clumsy and uncertain, and no safer than the ordinary operation of cholecystotomy.

To this opinion there may possibly be one exception—the operation *à deux temps* might possibly present advantages when cholecystotomy is being undertaken in the presence of chronic jaundice associated with a hæmorrhagic tendency and a distended gall-bladder in a patient extremely ill, as in such cases there is usually malignant disease either of the head of the pancreas or of the bile ducts; and when the peritoneum is exposed, but not opened, pressure can be applied to arrest the subsequent oozing of blood, which cannot always be prevented by ligatures or forceps. Bloch, however, in his original papers, and again in the *Revue de Chirurgie* for 1895, does not recommend the operation for this reason, but on account of the fear of septic contamination of the peritoneum, which ample experience proves to be groundless.

Results. Cholecystotomy or cholecystostomy is the safest operation on the gall-bladder as regards immediate mortality, and cannot be objected to on account of recurrence of gall-stones, which the experience of Mayo, Kehr, myself, and other surgeons shows to be extremely rare.

For statistical purposes the only classification it seems to me fair to make is into simple and malignant, for it must be generally acknowledged that the mortality of any operation must be considerable in such cases as cancer of the pancreas and common bile duct in which the only chance of giving even temporary relief may be by cholecystotomy.

In over 3,000 cholecystotomies performed by Mayo, Kehr, and myself in non-malignant disease, the mortality has been 1.8%, whereas when the operation has been performed for the relief of malignant disease the death-rate has been considerable, from 10% to even 30% or 40%.

CHOLECYSTECTOMY

Many surgical advances, especially in recent years, have been carried out with more zeal than discretion, and in several well-known instances the bounds of good judgment have at first been far passed, though ultimately moderation has prevailed. I here beg to offer a protest against the indiscriminate removal of the gall-bladder in all cases in which an operation on the bile passages is called for.

In 1904, at a meeting of surgeons in America, there was a decided preponderance of opinion in favour of cholecystectomy in all cases in which an operation is necessary for gall-stones, or for any other morbid condition of the gall-bladder, and I know that one or two British surgeons have adopted the same views.

Indications. I know it has been said that the gall-bladder is a useless organ, very liable to infection, whose debased function is that of forming concretions and ultimately becoming cancerous. On the other hand, I would urge, it must not be forgotten that gall-stones, though usually forming in the gall-bladder, may arise in any part of the biliary apparatus, both within and outside the liver; and as a matter of fact, I have seen gall-stones develop in a dilated common duct two years after a cholecystectomy, whereas in the very large experience of myself and several surgeons whose aggregate of cases of operations on the gall-bladder amounts to fully 3,000, it is universally acknowledged that the recurrence of gall-stones after cholecystotomy is an extremely rare event.

Bile is constantly being formed in the liver at the rate of about 1 ounce per hour, as I proved by a long series of observations some years ago (*Proc. Royal Soc.*, vol. xlvii), but it is normally only poured into the intestine after food has been taken and is passing through the pylorus, the sphincter at the orifice of the common duct opening in response to the reflex effect of the stimulus of food passing the pyloric sphincter. In the intervals the gall-bladder acts as a reservoir in storing the bile until it is required to neutralize the acid chyme and to help in emulsifying fat.

While the bile is in the gall-bladder mucus is added to it, and from observations made in 1899 I know that the amount of mucus is considerable, 72 c.c. in twenty-four hours. This serves the purpose of rendering the bile less irritating.

A series of experiments performed by Dr. Flexner demonstrated the fact that if pure bile is injected into the pancreatic ducts it sets up acute pancreatitis, but when bile is mixed with mucus the action is very considerably modified, and when a certain amount of mucus has been added it no longer acts as a serious irritant.

This would seem to prove that the admixture of mucus with bile in the gall-bladder may be important; and at the best it is merely an expression of ignorance to say that the gall-bladder has no useful purpose to serve.

It is a question whether the loss of the gall-bladder does not lead to a dilatation of the common duct so as to replace to a certain extent the reservoir function of the gall-bladder. That this has occurred in some cases I know from personal experience. If this be universal, it seems not unlikely that after cholecystectomy the dilated common and hepatic ducts may ultimately form a reservoir for the development of concretions. Moreover, if the bile ducts within and outside the liver have to act as reservoirs there must necessarily be back pressure on the secreting part of the liver and possibly biliary absorption, conditions which do not apply when the gall-bladder is acting as a bile store.

Sufficient time has not elapsed to show whether the liver is injuriously affected by this pressure and absorption, as it is only recently that cholecystectomy for almost normal gall-bladders has been adopted by some enthusiasts as a routine procedure.

Whether cirrhosis of the liver and the pancreas will result in a certain proportion of cases remains to be seen.

In ordinary cases of cholelithiasis, cholecystotomy with drainage of the gall-bladder is a very safe and efficient operation, and if the ducts are cleared there need be no fear of fistula or of recurrence of gall-stones. Seeing that cholecystotomy has led to such good results, both immediate and remote, in the surgery of gall-stones, the operation should not be too hastily condemned and replaced by cholecystectomy as a routine procedure. My own experience is that cholecystectomy, though a more prolonged operation than simple drainage of the gall-bladder, can with due care and in experienced hands be performed with hardly more immediate risk (in my last sixty cases only one death), and that when the gall-bladder is contracted and infected, or inflamed and thickened, or gangrenous, or much dilated, it is better to remove it.

I feel sure that if cholecystectomy were to become the routine procedure for inexperienced operators, the death-rate for gall-stone operations would be greatly increased. The rate of mortality shown in some of the recent works on gall-stones does not reflect credit on the hospitals whose statistics are quoted; the mortality of simple cholecystotomy should not exceed at the most 1% to 2%, and will not if due precautions are taken. If, however, these operations be done by inexperienced surgeons who have not taken the trouble to master the technique of the operation and of the after attendance, the mortality will continue to be considerable. But if the mortality of cholecystotomy in inexperienced hands is considerable, what would happen if a consensus of opinion was allowed to go forth that cholecystectomy is the operation that ought always to be performed for gall-stones? For every surgeon must acknowledge that it is much more difficult to remove the gall-bladder than simply to drain it. I hold that no one ought to do any operation for gall-stones who is not fitted by experience and surgical ability to perform choledochotomy, cholecystectomy, cholecystenterostomy, or any of the more serious operations on the bile ducts, as it is frequently impossible to say beforehand what operation may be required..

Since introducing the method of more completely exposing the biliary tracts when operating for gall-stones, I find no difficulty in deciding as to the bile ducts being quite free from concretions—a necessary condition before cholecystectomy is justifiable.

Seeing that recurrence of gall-stones after cholecystotomy with efficient drainage is an extremely rare event; that the danger of cholecystotomy in uncomplicated cholelithiasis is almost nil—not more than 1% to 2% over a large number of cases; that drainage of the bile passages after any gall-stone operation is distinctly advantageous; and that if at some future time it should be necessary to drain the bile passages—say, for obstructive jaundice or interstitial pancreatitis—the difficulties would be increased by the absence of a gall-bladder, though not by a cholecystotomy, my feeling is very decided, that cholecystectomy should not replace the simple operation of cholecystotomy as a routine procedure in operating for gall-stones.

Cholecystectomy is indicated in the following conditions:—

(i) In cancer or other new growth, where the disease is local or limited.

(ii) In contracted and useless gall-bladder, the result of repeated attacks of cholecystitis (see Figs. 128 and 129).

(iii) In dilated or hypertrophied gall-bladder resulting from obstruction in the cystic duct—

(*a*) Always, if resulting from stricture.

(*b*) Usually, if resulting from impacted gall-stones which may have induced ulceration that will subsequently lead to stricture.

(*c*) Usually, if resulting from kinking of the cystic duct or from adhesions.

(iv) In phlegmonous or gangrenous cholecystitis.

(v) In empyema of the gall-bladder.

(vi) In calcareous degeneration of the gall-bladder.

(vii) In mucous fistula of the gall-bladder, the result of stricture or other permanent obstruction of the cystic duct.

(viii) In biliary fistula, when the common duct is free from obstruction.

(ix) In gunshot or other serious injuries of the gall-bladder or cystic duct.

It is unnecessary in ordinary cholelithiasis where the gall-bladder is not seriously damaged and where the cystic duct is not ulcerated or narrowed by stricture; and it is contra-indicated where the surgeon cannot be certain that the deeper bile passages are free from obstruction, unless at the same time the cystic or common ducts be short-circuited into the intestine.

The conditions for which cholecystectomy may have to be performed may be conveniently divided into simple and malignant; no other classification seems to me necessary or desirable. In the former class the variety of the conditions for which I have performed the operation is considerable—phlegmonous cholecystitis, gangrene, ulceration, hydrops, perforation, adenoma, cystic disease, hour-glass contraction, inflammatory contraction and calcification of the gall-bladder, simple tumour, ulceration and stricture of the cystic duct, mucous and suppurating fistulæ, rarely biliary fistula, unless at the same time the common duct has been freed from obstruction. In the latter class, cancer, endothelioma, and sarcoma of the gall-bladder or cystic duct.

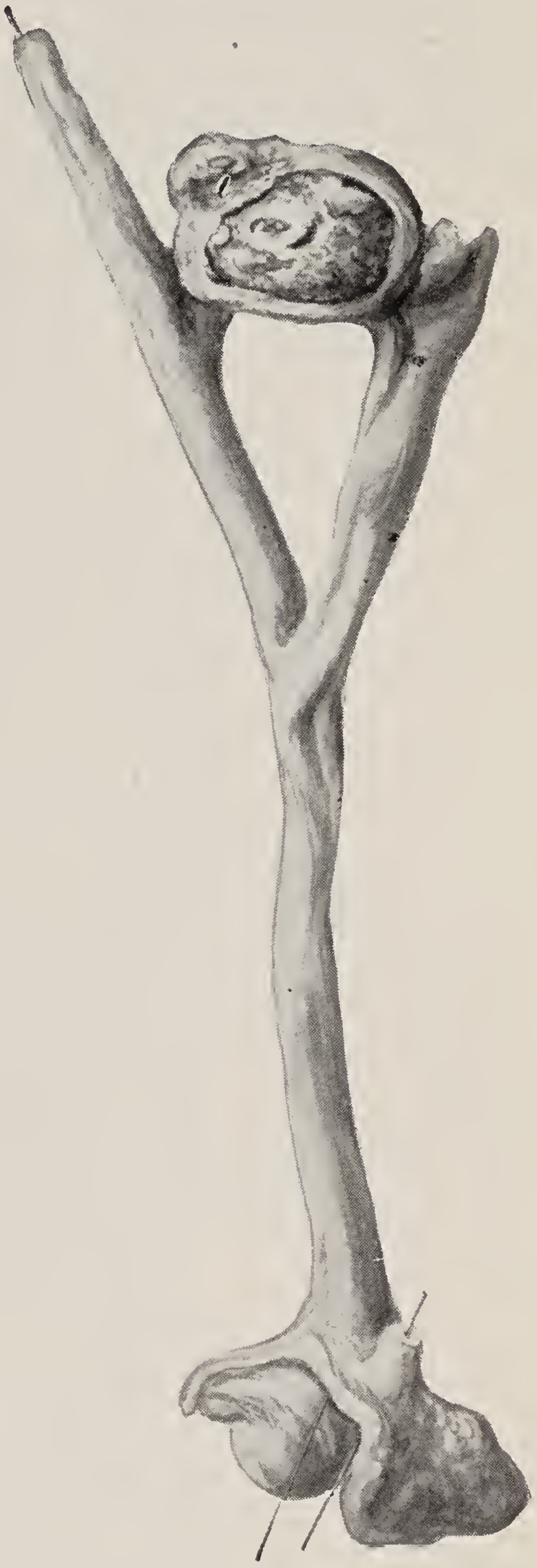


Fig. 128. Contracted Gall-bladder. Drawing of Specimen No. 2830 from the R. C. S. Museum. Showing a gall-bladder which has been practically destroyed by ulceration, a gall-stone, the cause of the trouble, being shown in a cavity outside the gall-bladder proper.

The after results of cholecystectomy in complicated gall-stone cases have been excellent; instead of prolonged drainage being necessary and a mutilated organ being left, liable to give further trouble, the wound as a rule has pursued an aseptic course, the drain has been removed in twenty-four to forty-eight hours, and primary union has occurred.

The ultimate results have usually been equally good, except in one

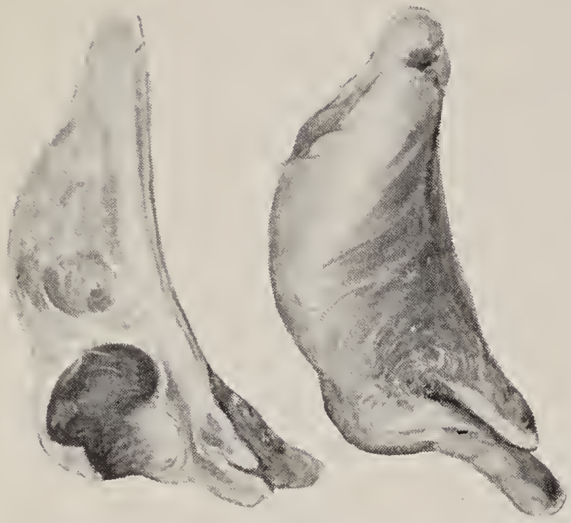


FIG. 129. CONTRACTED GALL-BLADDER WITH STRICTURED CYSTIC DUCT. Removed by the author from a lady, aged fifty-five, on December 1, 1904. She had had attacks of pain over the liver for ten years, and her health had been seriously affected by the repeated seizures. A small cavity in the gall-bladder was connected by a fistula with the duodenum. The patient made a good recovery.

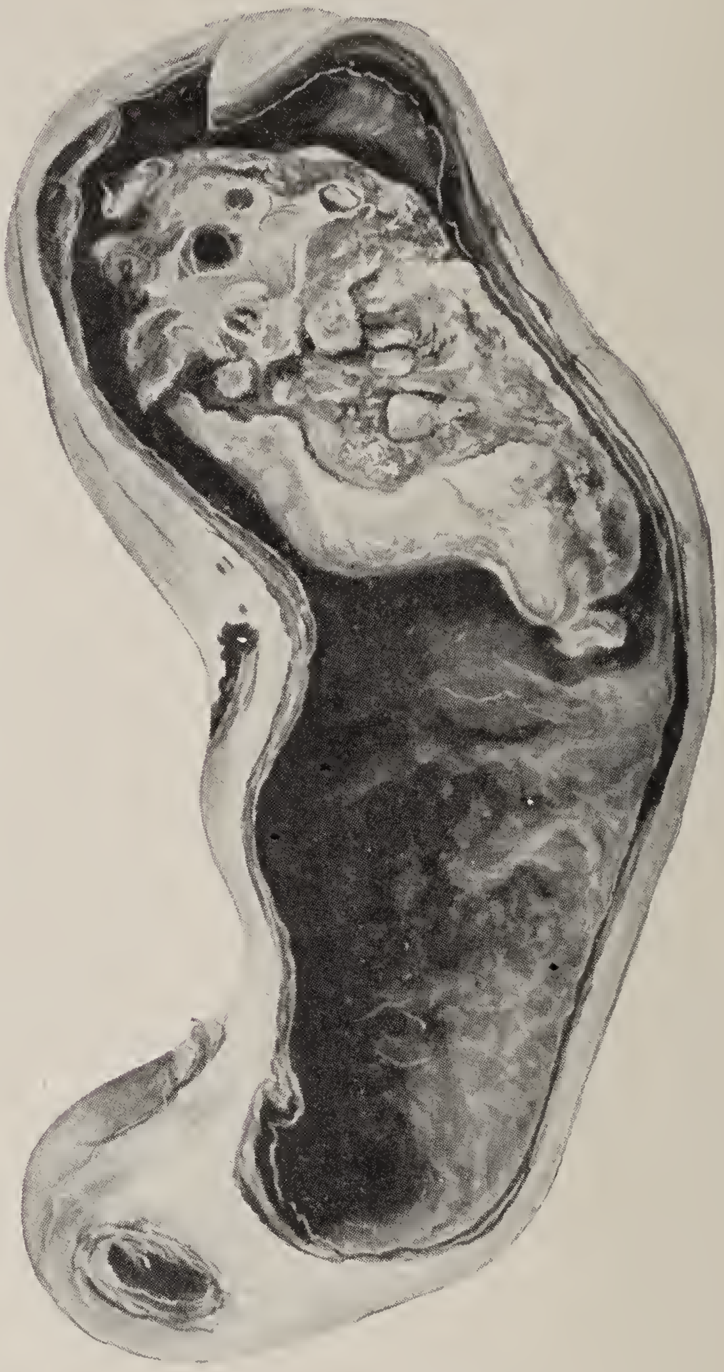


FIG. 131. INTERSTITIAL HÆMORRHAGE IN THE GALL-BLADDER. Drawing of Specimen No. 2830 K, R. C. S. Museum. A gall-bladder measuring 5 inches in length, which was excised by the author. Its walls are thickened so as to measure about ½ inch and its interior is of a deep black colour from congestion and interstitial hæmorrhage. With the gall-bladder is mounted a mass of exudation which was removed from within it at the operation and in which many small polyhedral calculi are entangled. The peritoneum is intensely congested. Microscopic sections reveal extensive interstitial hæmorrhage into, but no destruction of, the mucosa. Patient well a year later.

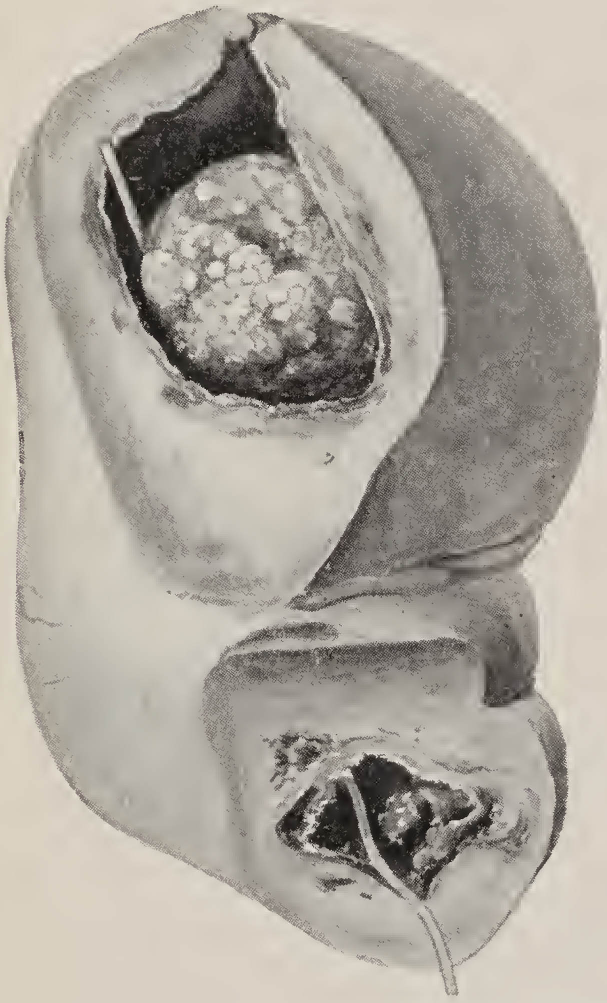


FIG. 130. A GALL-BLADDER WITH GREATLY THICKENED WALLS FROM CHRONIC INFLAMMATION. A calculus of considerable size lies in the fundus, and numerous other calculi are in the gall-bladder itself. Removed by the author. Good recovery.

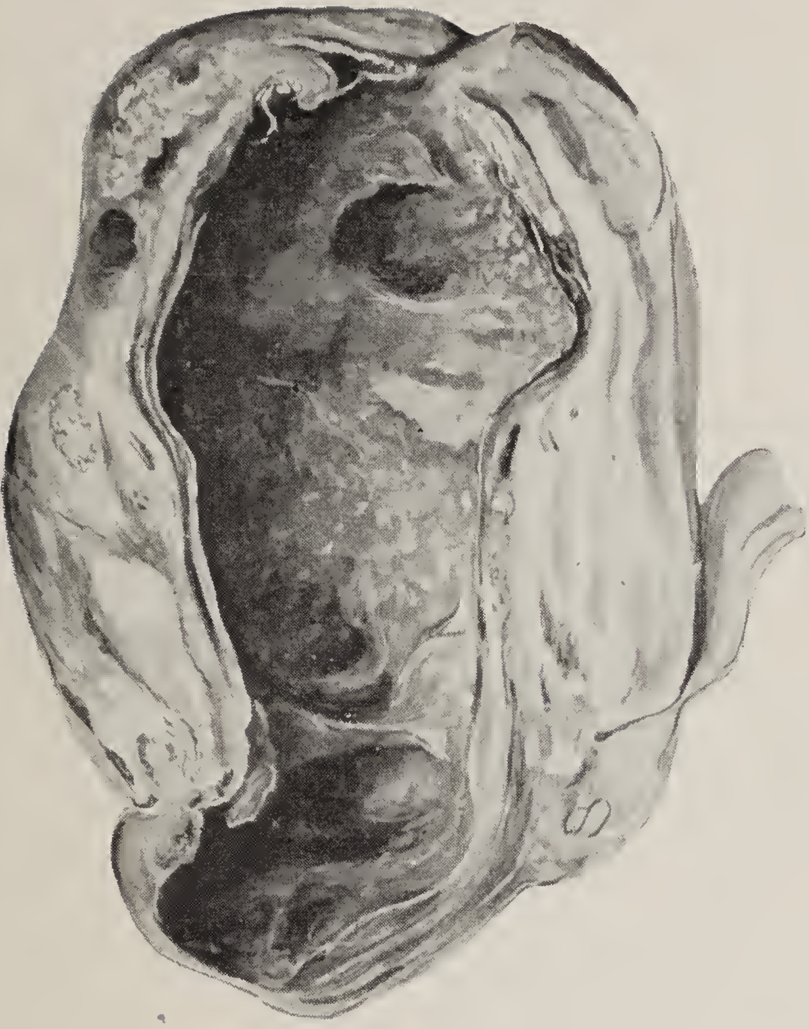


Fig. 132. Acute Infective Cholecystitis. Drawing of Specimen No. 2830 J, R. C. S. Museum. A gall-bladder the walls of which are much thickened from acute infective inflammation, the swelling reaching a maximum of ¾ inch. The mucosa is of a deep brownish-black colour; the peritoneum is intensely and uniformly congested. The gall-bladder contained three large calculi. The deep colour of the mucosa is chiefly due to interstitial hæmorrhage; the lining epithelium has not been shed. The parts were removed from a middle-aged lady on February 20, 1905. On the 17th she had been seized with severe pain in the right side of the abdomen, but until then had had no trouble. When seen her temperature was 104° F., pulse 120. There were signs of peritonitis in the region of the gall-bladder. Operation was carried out on the following morning. A sero-purulent exudation was found in the general peritoneal cavity, and the exterior of the gall-bladder was of a plum colour. The patient made a good recovery after cholecystectomy.

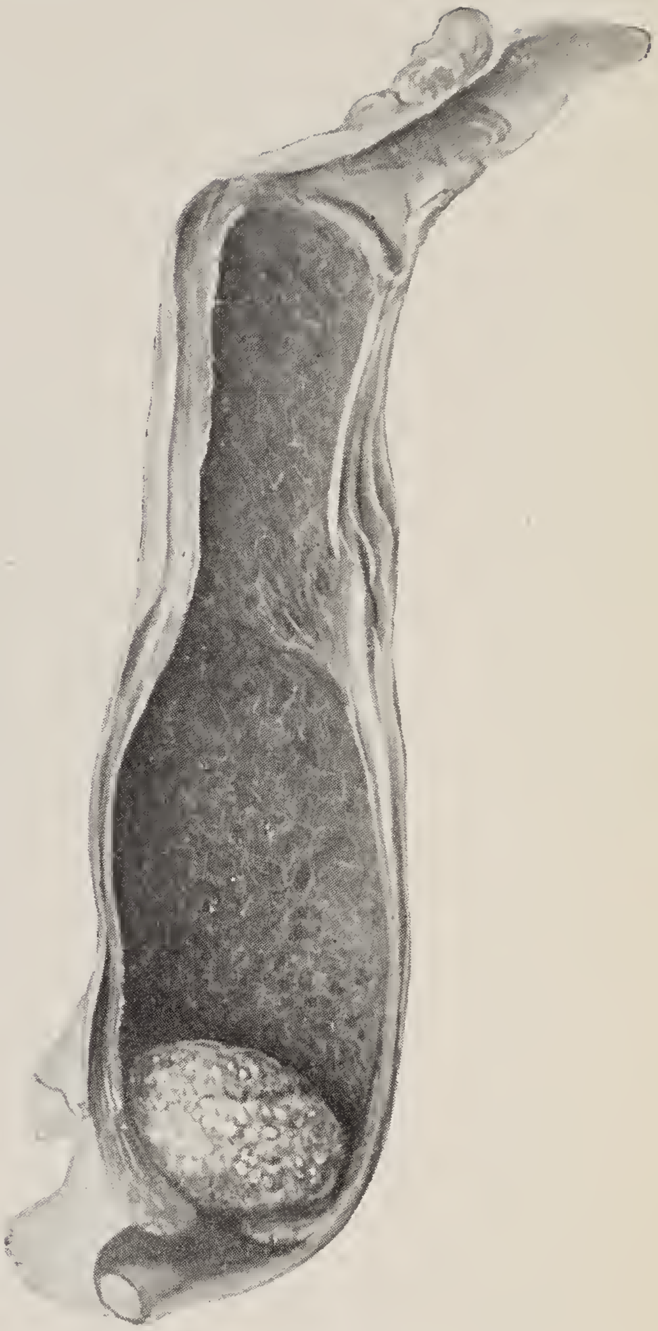


Fig. 133. Gall-stone impacted in the Cystic Duct, causing a Biliary Fistula. Drawing of Specimen No. 2830 O, R. C. S. Museum. A gall-bladder with a biliary fistula, showing a gall-stone impacted in the beginning of the cystic duct. From a lady, aged thirty-six, who had had cholecystotomy performed in South Africa some months previously during acute cholecystitis, when the gall-bladder had been simply stitched to the surface and emptied. No bile flowed through the fistula until after an attack of vomiting six weeks later, since which time there had been an irregular flow of bile with occasional attacks of pain. The gall-bladder, including the fistula, was completely removed by the author in November, 1904, together with the stone impacted in the first part of the cystic duct. Good recovery followed.

case where a recurrence of gall-stones took place two years later, and I had to perform choledochotomy and to drain the common duct.

In the malignant cases operation is necessarily formidable, and unless the disease is strictly localized to the gall-bladder and adjoining part of the liver it is better to stop at an exploratory operation; though I cannot forget that in one of my cases where I removed a portion of the liver with the gall-bladder, and in another where I removed the pylorus along with a portion of the liver and the gall-bladder, the patients are now living and well, six and a half years and over five years respectively after operation.

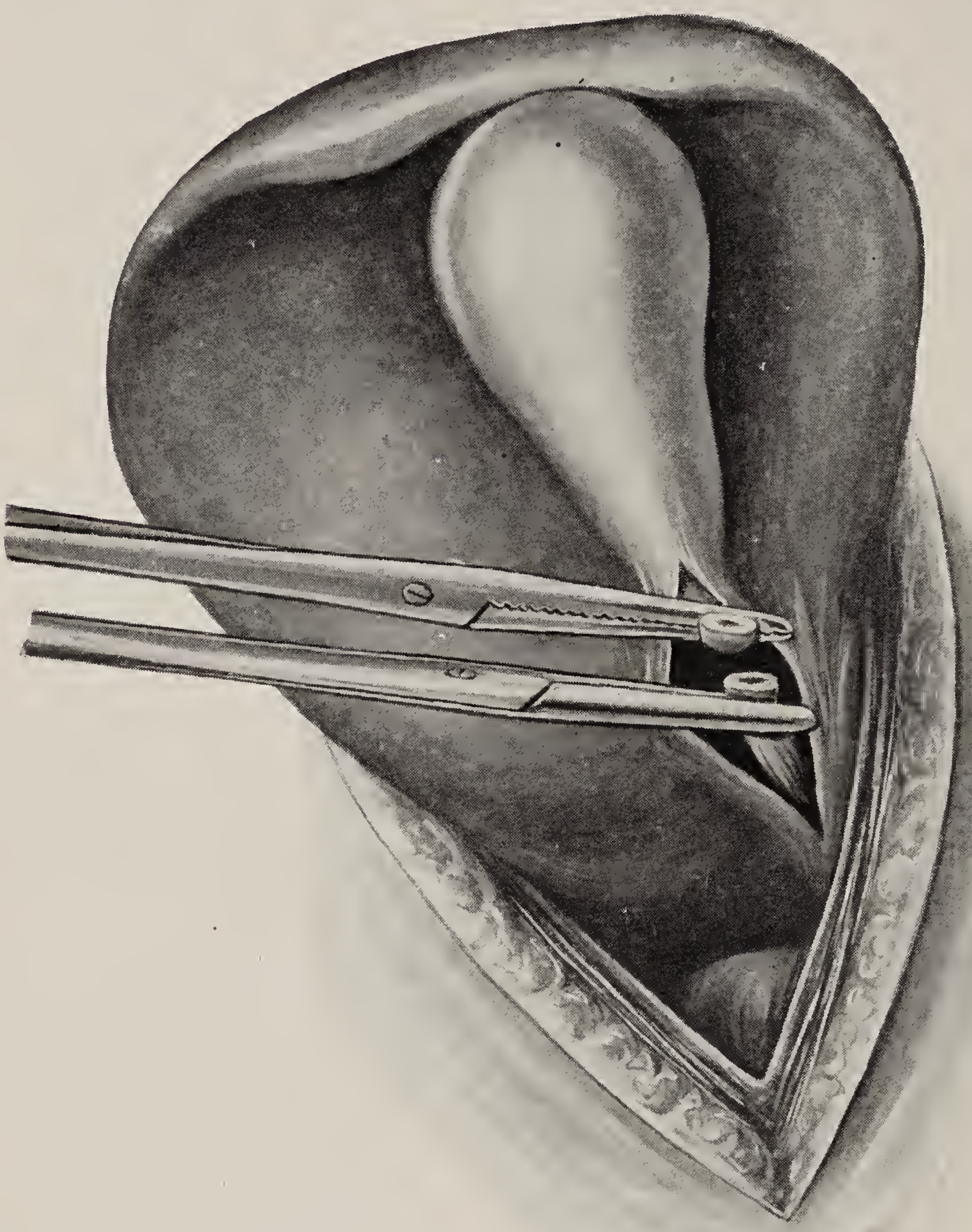


Fig. 134. Cholecystectomy. Seizure of the cystic duct.

Operation. The preparation of the patient and other details, including the first stages of the operation, have been already described on p. 275, the incision being the one shown in Fig. 117.

After separating adhesions, it will be found that by lifting the lower border of the liver in bulk (if needful first drawing the organ downwards from under cover of the ribs, as shown in Fig. 118, p. 279) the whole of the gall-bladder and the cystic and common ducts are brought quite close to the surface, and as the gall-bladder is usually strong enough, an assistant can take hold of it or the liver with his fingers covered with an aseptic swab, and by gentle traction can keep the parts well exposed, at the same time that, by means of his left hand, he retracts the left side of the wound and the viscera, which would otherwise impede the view.

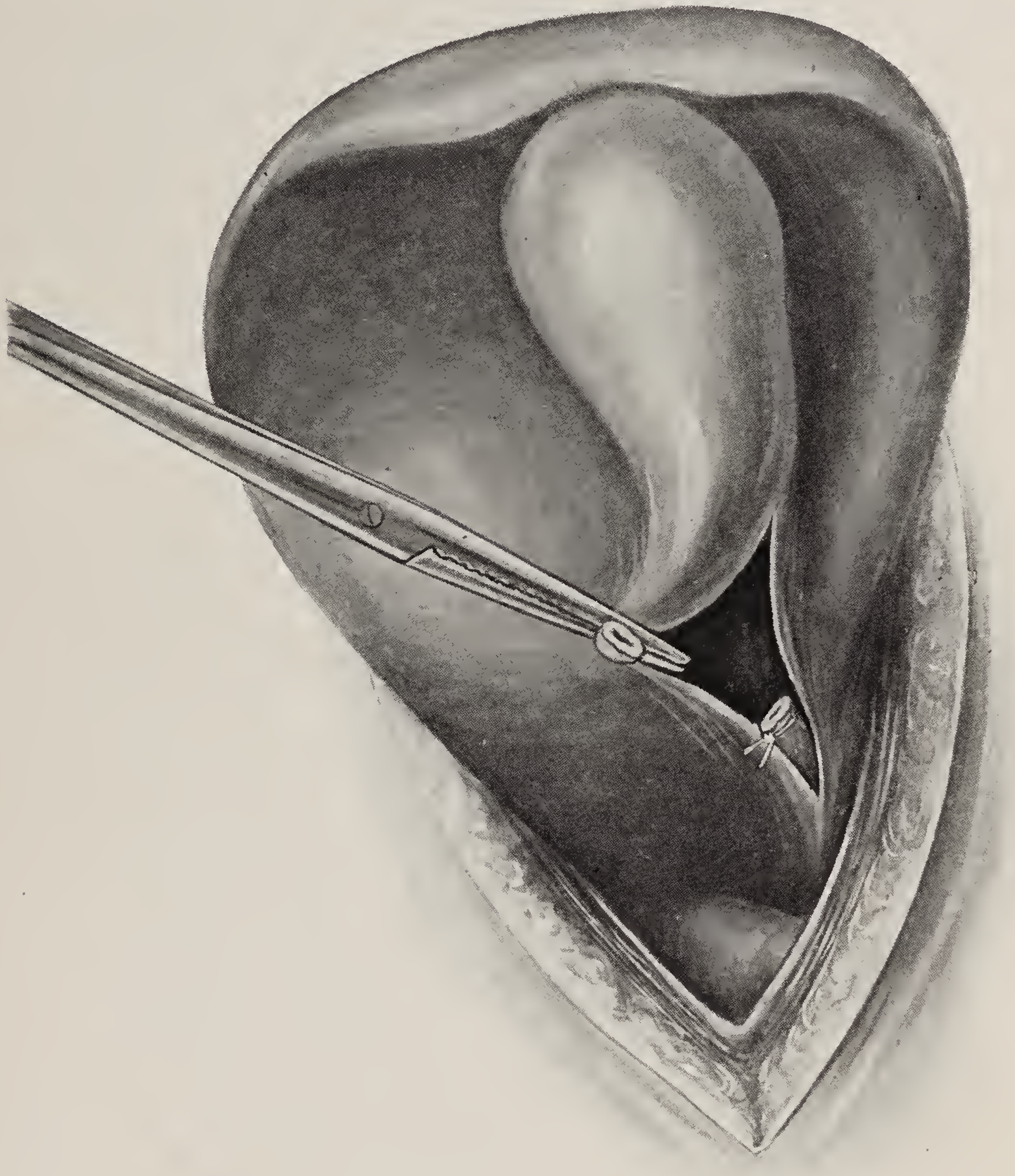


Fig. 135. Cholecystectomy. Ligature of the distal end of the cystic duct and commencement of the separation of the gall-bladder from below.

It will now be observed that instead of the gall-bladder and cystic duct making a considerable angle with the common duct, an almost straight passage is found from the fundus of the gall-bladder to the entrance of the bile duct into the duodenum, and if adhesions have been thoroughly separated the surgeon has immediately under his eye the whole length of the ducts, with the head of the pancreas and the duodenum. By inserting a gauze pad into the kidney pouch, another into the wound on the left side so as to cover the stomach, and a third below, so as to protect the lower end of the wound, all fear of soiling the peritoneum or the surrounding viscera is avoided.

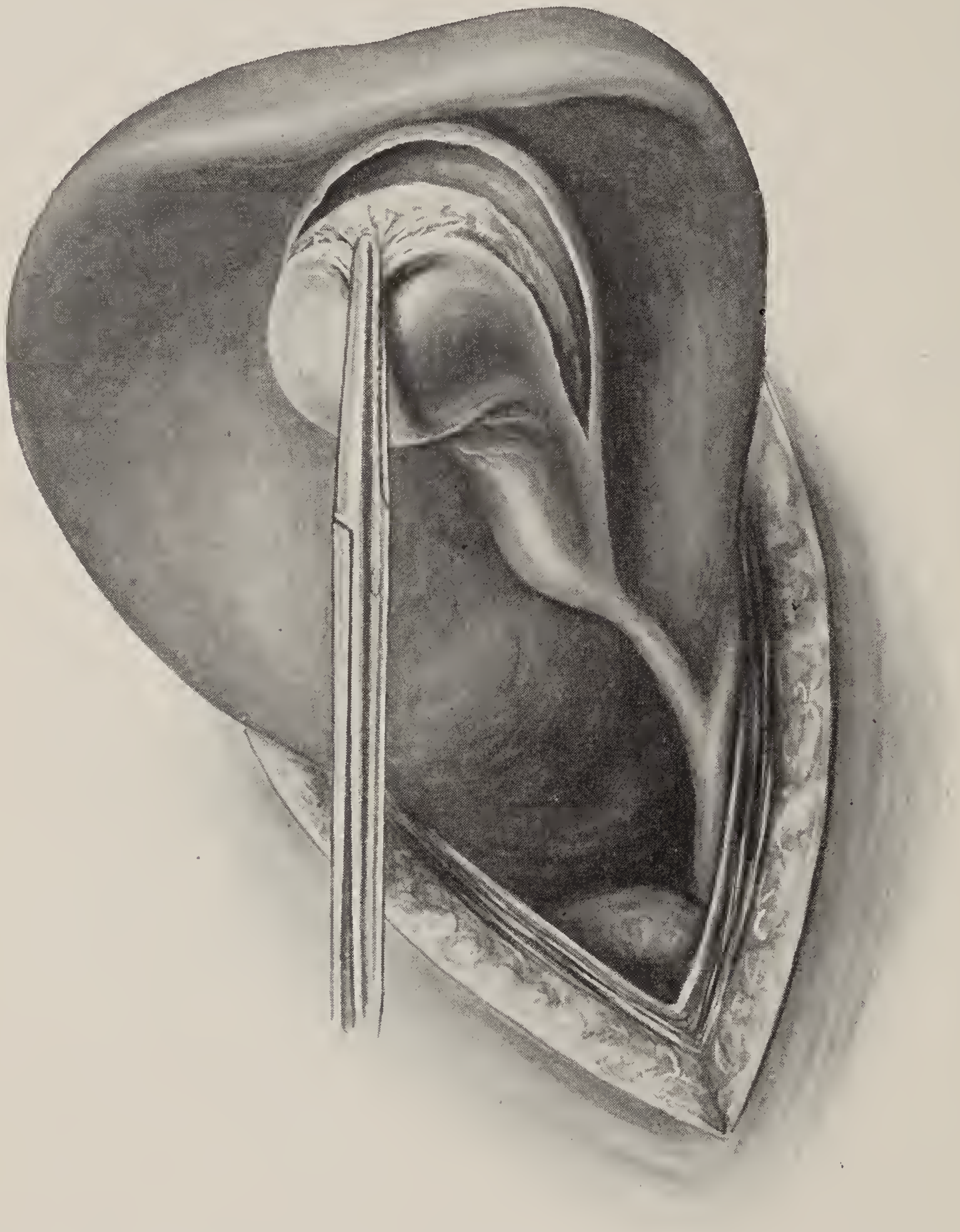


FIG. 136. CHOLECYSTECTOMY. Separation of gall-bladder from above downwards.

After the common and hepatic ducts have been satisfactorily cleared or explored and found to be free from obstruction, the cystic duct is seized a little beyond its entrance into the common duct by means of strong pressure-forceps, which at the same time grasp the cystic artery and thus control bleeding during the remaining stage of the operation. Another pair of pressure-forceps is employed to seize the cystic duct

½ inch nearer to the gall-bladder, and between the two forceps the duct is divided. The finger or a blunt dissector can now be used to separate the gall-bladder from its bed, and as it is separated the peritoneum on each side is divided by scissors 1/3 inch from its reflection on to the liver, care being taken to avoid wounding the liver. Sometimes it is easier to carry the separation from above downwards, but usually the dissection can be more easily effected from below upwards. Any bleeding points may now be ligatured, and the cystic artery, which was divided between the clamps, can be seen and readily secured by ligature. The open end of the cystic duct is now seized and ligatured, or

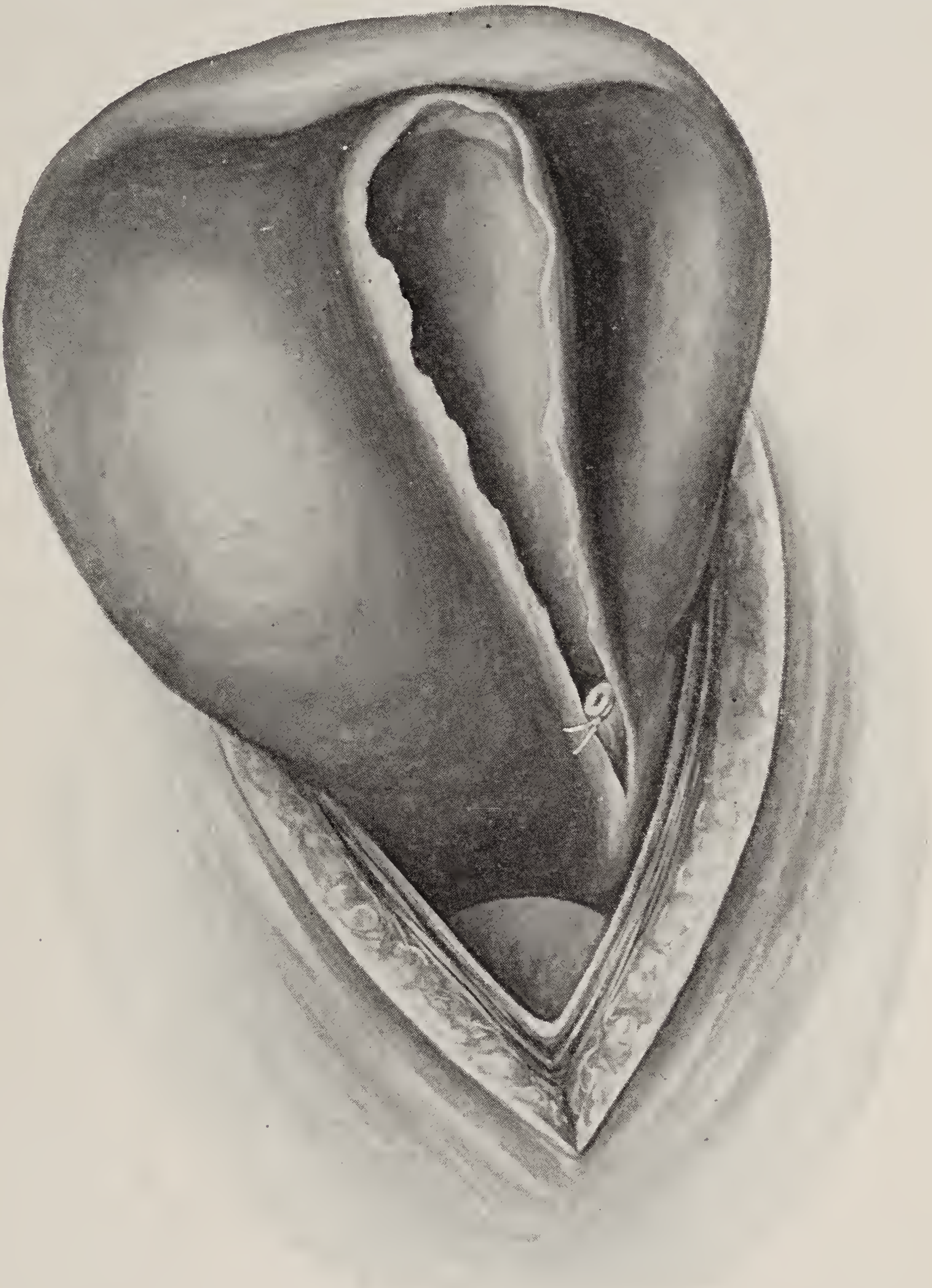


FIG. 137. CHOLECYSTECTOMY. Cavity left after removal of the gall-bladder. Ligatured cystic duct about to be buried beneath the peritoneum.

stitched up by a fine chromic catgut suture, and the stump is then buried beneath the peritoneum, which is readily brought over it. An ordinary No. 2 iodized, not chromicized, catgut suture is then continued upwards, bringing together the cut peritoneal edges on each side of the gall-bladder fissure of the liver, so as to obliterate the fissure and leave no dead space. A gauze drain may be passed down to the duct, but this is not always necessary if the operation has been cleanly conducted; though if the gall-bladder or ducts have been infected and the wound has run any risk of contamination, it will be safer to drain by means of a rubber tube enclosing a thin strip of iodoform gauze. Where there is infection of the common bile duct or of the liver ducts it is advisable to insert a drainage tube into the divided and open end of the

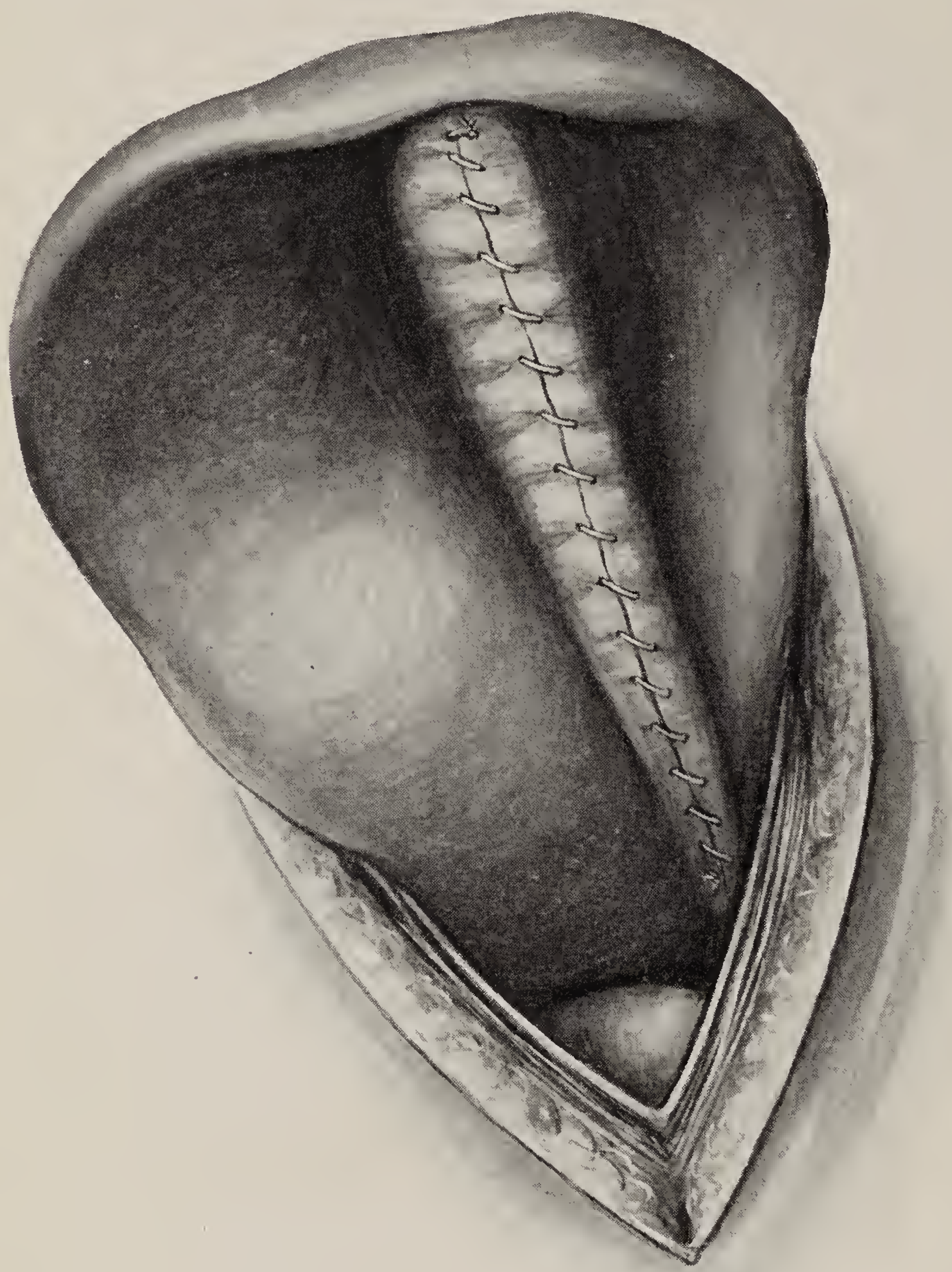


FIG. 138. CHOLECYSTECTOMY. Closure of gall-bladder fissure by bringing together the divided peritoneal edges.

duct, the tube being fixed in place by a catgut suture and surrounded by a purse-string suture of catgut. This will remain *in situ* for a week without any fear of leakage, and by the time the catgut has dissolved a track will have been isolated from the general cavity of the peritoneum, so that the tube may then be safely removed or left in longer should more prolonged drainage be necessary. The form of tube I usually employ is a No. 12 Jaques's catheter. In order to avoid visceral adhesions I usually bring the right border of the omentum up and place it between the tube and the viscera. It is better to bring this tube, or whatever drain is used, through a separate stab wound external to the abdominal incision, thus enabling the large incision to be closed securely.

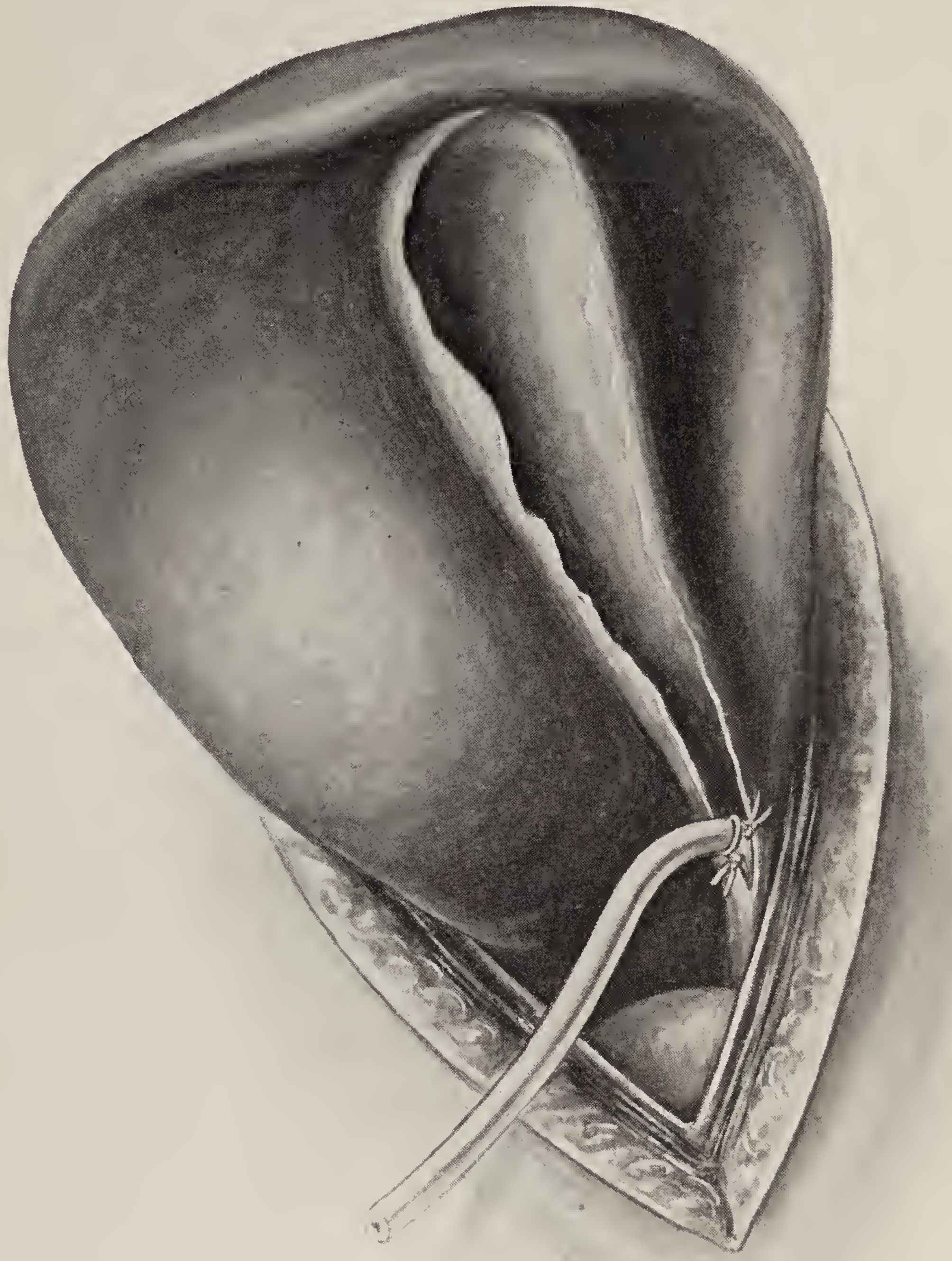


FIG. 139. CHOLECYSTECTOMY. Drainage of the cystic duct.

If the patency of the common duct be doubtful, yet the gall-bladder is too badly damaged to be safely retained, the cystic duct may be cut long and the open end anastomosed into the duodenum, either directly by suture or by means of a small decalcified bone bobbin, so as permanently to short-circuit the obstruction. This may be advisable in cases where the pancreas is inflamed and compressing the bile duct.

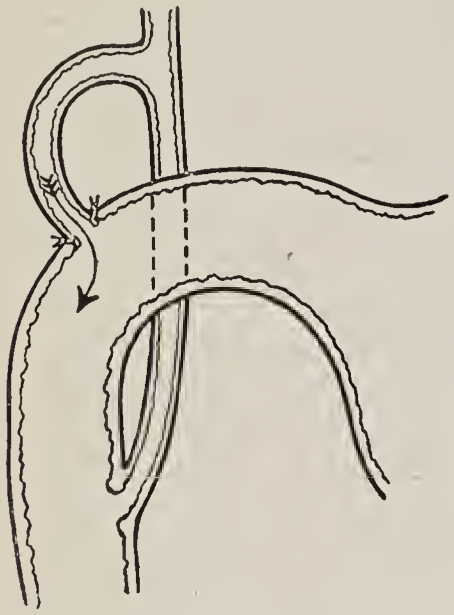


Fig. 140. Cholecystectomy followed by Anastomosis of the Cystic Duct to the Duodenum.

The method of closure of the abdominal wound and other details of subsequent treatment have been described under Exploratory incision.

If the liver be torn in separating adhesions the bleeding must be carefully arrested before the abdomen is closed. Sponge pressure is usually sufficient if the laceration be small, but if the laceration be extensive, deep catgut sutures, applied by means of a round intestinal needle, will usually accomplish the desired effect, or this failing, gauze pressure, the plug being left in until it becomes loose, will be certain to answer.

Results. In about 1,000 cases of cholecystectomy collected from various sources the mortality is close on 5%, though it is only a little over 2% in the hands of some operators. In my last eighty cholecystectomies the mortality is just over 3%, and this includes both simple and malignant cases. In the 1907 report of the Rochester Clinic, U.S.A., the mortality is 3%.

CHOLECYSTENTEROSTOMY

The operation has for its purpose the establishment of a new channel for the passage of bile from the gall-bladder to the intestine in case of obstruction in the common duct which it is impracticable to remove by operation.

It consists in establishing an artificial opening between the gall-bladder and some portion of the intestine, preferably the duodenum, though in some cases in which the extreme illness of the patient, the presence of adhesions, or the absence of efficient help render that anastomosis impracticable, the gall-bladder may be more easily united to a loop of the jejunum or even to the hepatic flexure of the colon.

Although the conception of the operation occurred independently to Harley, Gaston, and Nussbaum, the first operation was actually performed by von Winiwarter of Liége, who completed it in six stages between July, 1880, and November, 1881; my case in 1889 was the first performed in England and was the first cholecystenterostomy performed for the cure of a biliary fistula. The anastomosis was done in one stage and was accomplished by a double row of sutures.

Indications. The operation may have to be undertaken for—

(i) Interstitial pancreatitis which by obstructing the common bile duct leads to chronic jaundice.

(ii) Tumour or cancer of the head of the pancreas.

(iii) Tumour of the common bile duct.

(iv) Rupture of the common duct in which ligature of the duct has been rendered necessary.

(v) Stricture of the common duct following gall-stone obstruction or ulceration.

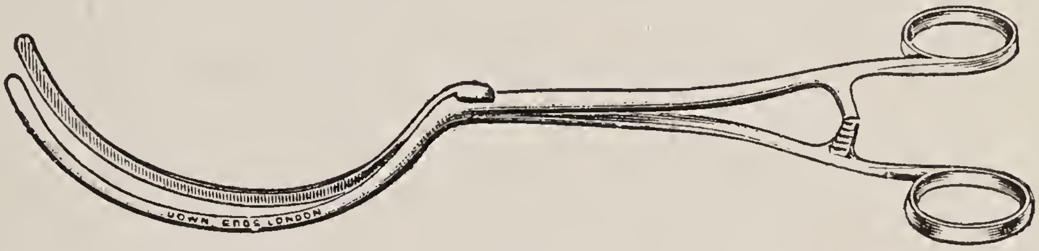


Fig. 141. Curved Forceps used by the Author in Gall-bladder Anastomosis.

(vi) Biliary fistula, either following operation or as a sequela of pathological changes in which the obstruction to the bile flow cannot be removed.

(vii) Distended gall-bladder in which drainage is for some cause undesirable and where cholecystectomy is contra-indicated.

Contra-indications. (i) Gall-stone obstruction.

(ii) Small and atrophied gall-bladder.

(iii) Obliteration or stricture of the cystic duct with enlargement of the gall-bladder, in which cholecystectomy is indicated.

(iv) Malignant disease of the head of the pancreas or common bile duct leading to distension of the gall-bladder. In this condition the mortality of the operation is so great and the relief in case of recovery of such short duration that the operation is hardly worth performing.

Operation. Having exposed the gall-bladder as already described, and placed the patient in the position shown in Fig. 116, p. 277, the gall-bladder, if distended, must be emptied by trochar or aspirator and the fundus of the empty sac be grasped by the small curved clamps shown in Fig. 141. The duodenum at the junction of the first and second portions must now be mobilized, if necessary, sufficiently to allow of a portion of the anterior wall being grasped in another pair of small curved clamps. On placing the two clamps parallel the grasped portions of the gall-bladder and duodenum will be placed close together, thus facilitating the application of sutures.

A fine Pagenstecher's thread is first applied, uniting the serous surfaces of the two viscera for at least an inch in length, the needle being then laid aside still threaded, to use later: this picks up the serous and subserous coats only. An incision is now made into the gall-bladder and into the duodenum parallel with the first line of suture, but about 1/3 inch in front of it and about ¾ inch in length. Small tenaculum forceps (see Fig. 142, c) are now inserted into each end of the visceral incision, one blade being in the gall-bladder and one in the duodenum, thus putting the incision on the stretch and bringing the edges into apposition. A fine chromic catgut suture is then used to join the two

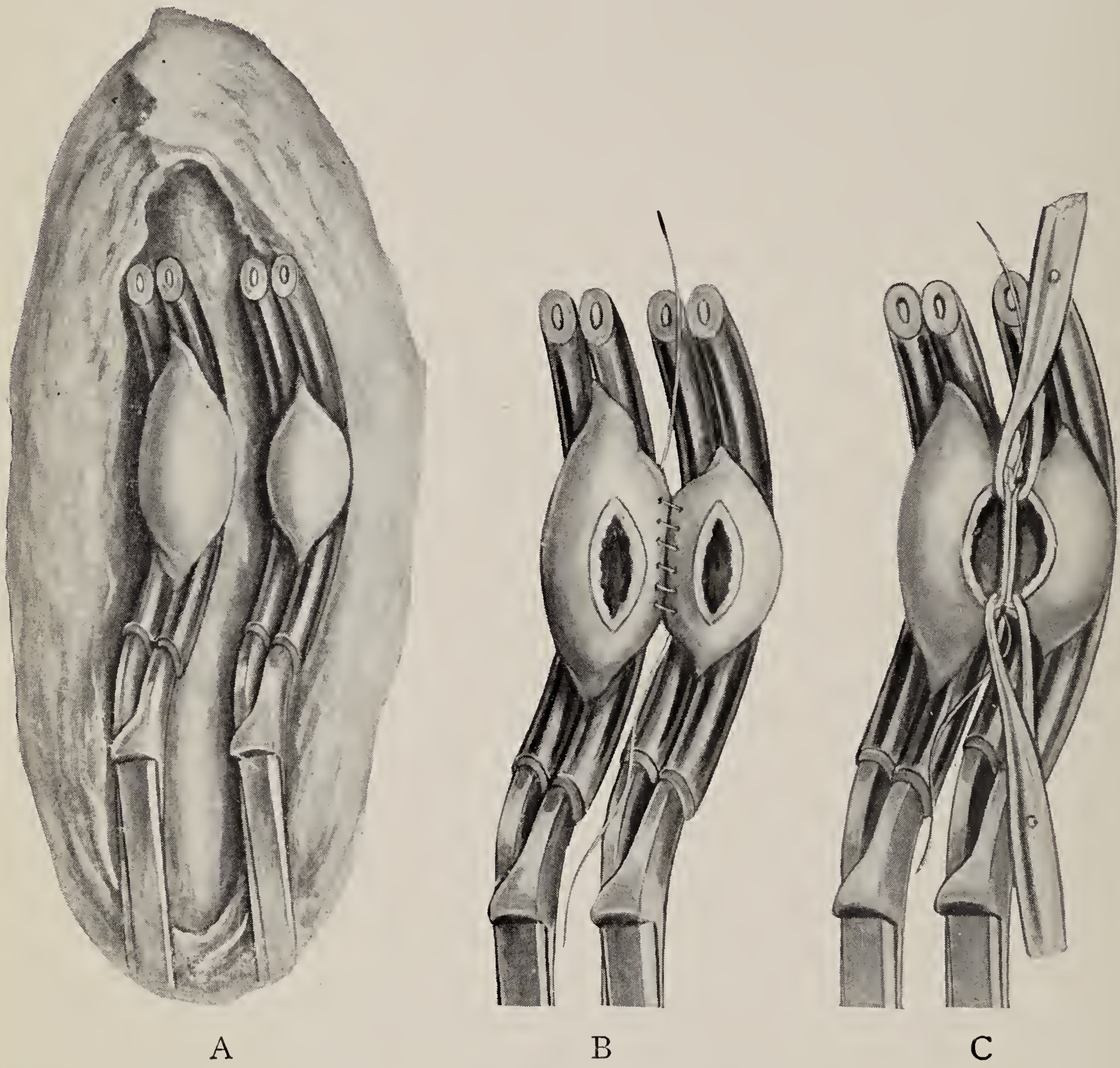


FIG. 142. CHOLECYSTENTEROSTOMY.
A, First stage; B, Second stage; C, Third stage.

margins of the visceral incision, embracing all the coats and securing the apposition of the mucous surfaces of the duodenum and gall-bladder. This is continued round the whole circle of the aperture that is to be the anastomotic opening, and when it reaches the point whence it started it is knotted and cut short. The serous suture previously laid aside is then picked up and continued around outside the marginal suture, until the circle is completed, when it is also knotted and cut short.

Thus is completed the union of the viscera, and after removing the clamps and wiping gently with a swab wet with normal saline solution, the omentum is arranged around the junction and the abdominal wound is closed as described on p. 278. If clamps have been used and due care has been observed, drainage of the right kidney pouch is unnecessary.

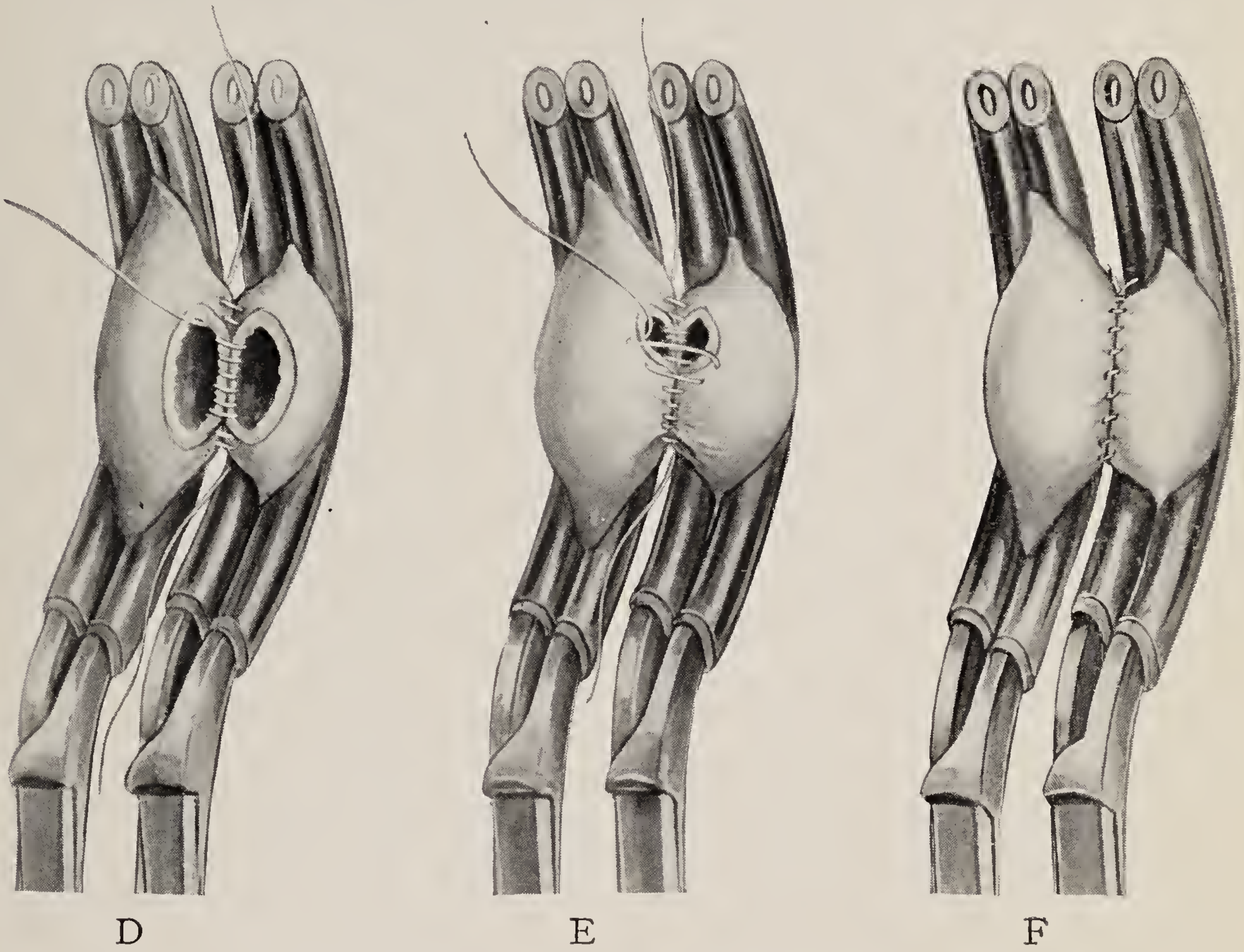


Fig. 143. Cholecystenterostomy.
D, Fourth stage; E, Fifth stage; F, Final stage.

This is the method I have employed for some years and which I can recommend after considerable experience. I employed union by suture in my first cases, then I used the decalcified bone bobbin for a time as a splint over which to apply the sutures, and afterwards a Murphy button, but after one experience of having the button retained and another of having the opening close within a few months after the employment of a button, I returned to the method by simple suture.

Modifications. If the gall-bladder duodenal junction (see Fig. 144) appears to be impracticable on account of adhesions or from other reasons, it has been suggested that an anastomosis may be made between the stomach and gall-bladder.

Terrier, in 1902, collected seven cases which appeared to show that bile in the stomach is not injurious; it is, however, certainly undesirable, and this modification should not be performed when other methods are available. Nor can I recommend union to the colon (see Fig. 145), which is the simplest of all these anastomoses, except in those cases where a rapid anastomosis is very desirable in patients extremely ill, as in obstruction from cancer of the head of the pancreas. Although union to the colon has usually been successful—in fact one of my earliest cases was to the colon and the patient was in good health many years later—yet I do not recommend it from the fact that I know of one case under the care of a colleague and have heard of others in which septic infection produced suppurative cholangitis and abscess in the liver. If, therefore, the duodenum be not available, I strongly recommend the commencement of the jejunum being found and a point about 18 inches from the duodeno-jejunal junction being brought up and united to the gall-bladder as shown in Fig. 146; at the same time an entero-anastomosis may be made very quickly between the two arms of the jejunal loop (see Fig. 147). The use of the clamps and the methods of applying the sutures are similar to those described in uniting the gall-bladder to the duodenum.

If the patient be very ill and time a serious object, the latter part of the operation (entero-anastomosis) can be omitted.

Still another method has been suggested—dividing the jejunum and uniting the proximal end of the distal portion to the gall-bladder and the distal end of the upper portion into the jejunum at a lower level. I have had no experience of this, nor can I see that it has any advantages over the previous method.

Results. Cholecystenterostomy, though in itself a comparatively simple operation, is one practically only undertaken in serious conditions, such as complete obstruction of the biliary passages by growth of the common bile duct or head of the pancreas, or by interstitial pancreatitis.

When undertaken for the temporary relief of malignant disease the mortality is necessarily very considerable, probably not less than 50%, whereas when the jaundice for which the operation is undertaken is dependent on non-malignant conditions, though the patients as a rule are extremely ill, the mortality has only been 4% in my experience of over sixty cases.

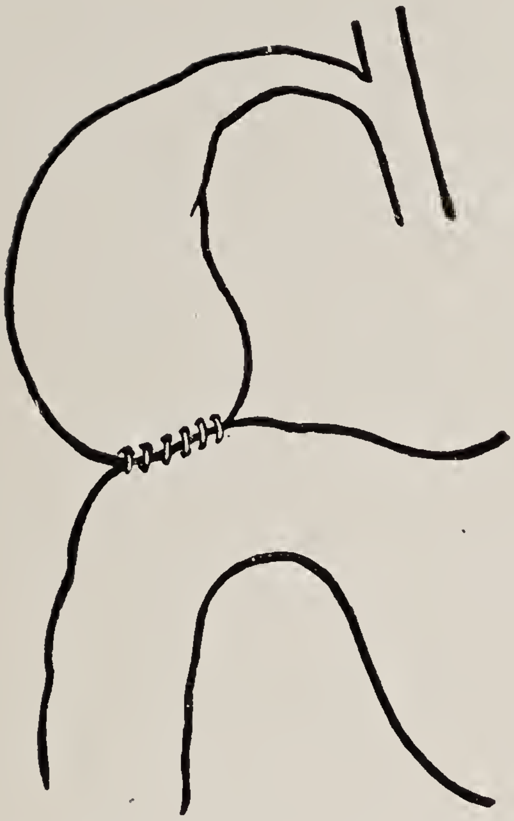


FIG. 144. UNION OF THE GALL-BLADDER TO THE FIRST PART OF THE DUODENUM.

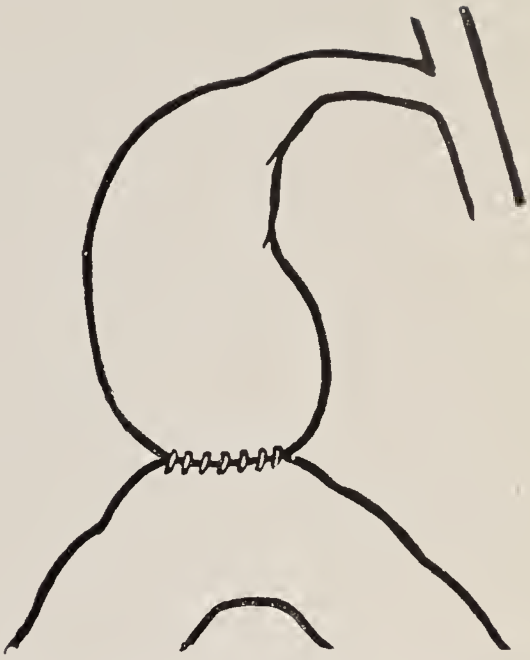


FIG. 146. UNION OF THE GALL-BLADDER TO THE JEJUNUM.

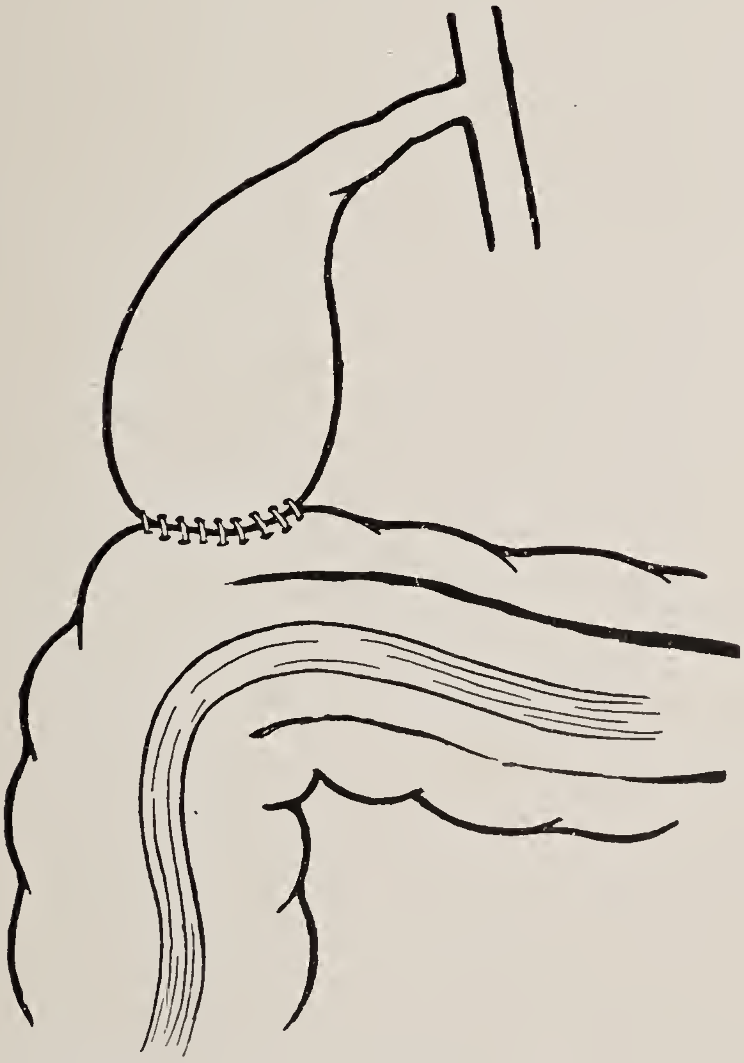


FIG. 145. UNION OF THE GALL-BLADDER TO THE COLON.

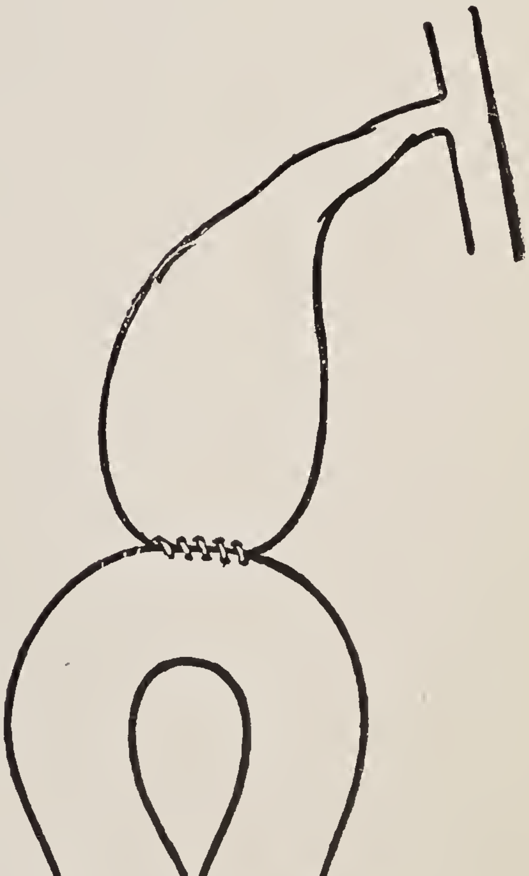


FIG. 147. UNION OF THE GALL-BLADDER TO THE JEJUNUM COMBINED WITH ENTERO-ANASTOMOSIS.

CHAPTER III

OPERATIONS UPON THE BILE DUCTS

CHOLEDOCHOTOMY

By choledochotomy is understood the operation of exposing and opening the common bile duct. It is usually required for the removal of gall-stones from the common duct, but through the incision concretions may also be removed from the hepatic duct.

It was first suggested by Langenbuch in 1884, though Kummell (quoted by Fenger) stated in 1890 that he, several years before, had performed cholecystectomy on a female patient of forty, after which he had removed a stone the size of a walnut from the common duct through an incision which he afterwards sutured. The operation was a very prolonged one and the woman died twenty-four hours afterwards.

Courvoisier performed the first successful operation on January 22, 1890, and two more, both successful, in February and March of the same year.

Since that time it has been done by many surgeons, and at the present time it may be confidently asserted that there is no portion of the gall-bladder and common, cystic, or primary divisions of the hepatic duct which cannot, under ordinary circumstances, be reached for the removal of calculi.

Operation. The bile ducts are fully exposed as described on p. 276. When the liver is lifted or rotated and the hepatic region elevated mechanically, the surgeon with his left forefinger and thumb can so manipulate the common duct as to render prominent any concretions, which can then be directly cut down on, the edges of the opening in the duct being caught by pressure-forceps. The assistant can now take hold of the forceps with his left hand, as they will form a sufficient retractor, since the duct is so near the surface.

When the duct is incised there is usually a free flow of bile, which, it must be remembered, is probably infective, but by protecting the edges of the wound by sterile gauze and by packing swabs into the kidney pouch and over the viscera on the left side and below, and rapidly mopping up the bile as it flows, by means of sterilized gauze pads, any soiling of the surrounding parts is avoided. If thought necessary, the bulk of the infected bile can be drawn off by the aspirator either from the gall-bladder or from the common duct above the obstruction before the incision into the bile passage is made.

The edges of the wound are protected by being covered with a long sterile gauze swab which may be held in position by temporary sutures or forceps.

After removing all obvious concretions by means of the scoop, the fingers are passed behind the duodenum and along the course of the hepatic ducts to feel if other gall-stones are hidden there, and a gall-stone scoop, the only special instrument I use, is passed into the primary division of the hepatic duct in the liver and down to the duodenal orifice of the common duct; and to ensure the opening into the duodenum being patent, a long probe is passed into the bowel. As the duct is usually dilated, it is easy to insert the finger through the incision in the duct and to thoroughly explore the whole of the common duct to see that no concretions have been overlooked.

As the bile is practically always infected in common duct cholelithiasis, drainage of the bile passages should always be carried out, preferably through a cholecystotomy, but where that is impracticable it is advisable to drain the common duct through a tube inserted into the incision through which the gall-stones have been removed.

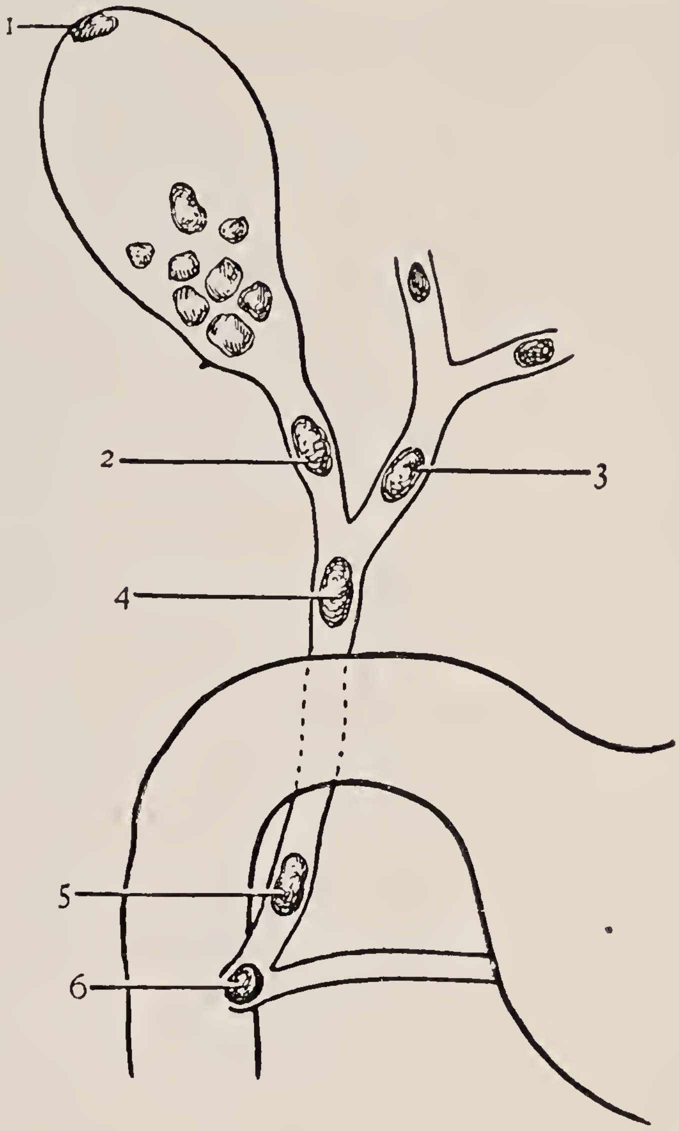


Fig. 148. Diagram to show the Position of Calculi in the Biliary Passages and the Points at which they may be reached for Removal. 1, Site of incision for cholecystotomy; 2, Site of incision for a gall-stone impacted in the cystic duct; 3, Site of incision for a gall-stone impacted in the hepatic duct; 4, Ordinary site of incision for choledochotomy; 5, Site of incision for transduodenal choledochotomy; 6, Ordinary site of incision for duodeno-choledochotomy.

The incision into the bile duct (when the gall-bladder is available for drainage) is closed by an ordinary curved, round needle held in the fingers without any needle-holder, a continuous catgut suture being used for the margins of the duct proper, and a continuous fine green chromic catgut suture being employed to close the edges of the peritoneum over the duct (see Fig. 150).

When the gall-bladder is contracted and not available for drainage, especially if the pancreas is indurated and swollen from chronic pancreatitis and likely to exert pressure for a time on the common duct, I insert a firm drainage tube (preferably a No. 12 Jaques's catheter) directly into the duct, passing it upwards into the hepatic duct, and closing the opening around it by a purse-string suture, the tube being fixed into the opening by a catgut stitch which will hold for about a week (see Fig. 151). Where, however, the size of the gall-bladder will permit of it, I prefer to suture the opening in the duct and to fix a drainage tube into the fundus of the gall-bladder, as this drains away all infected bile and avoids pressure on the newly sutured opening in the duct.

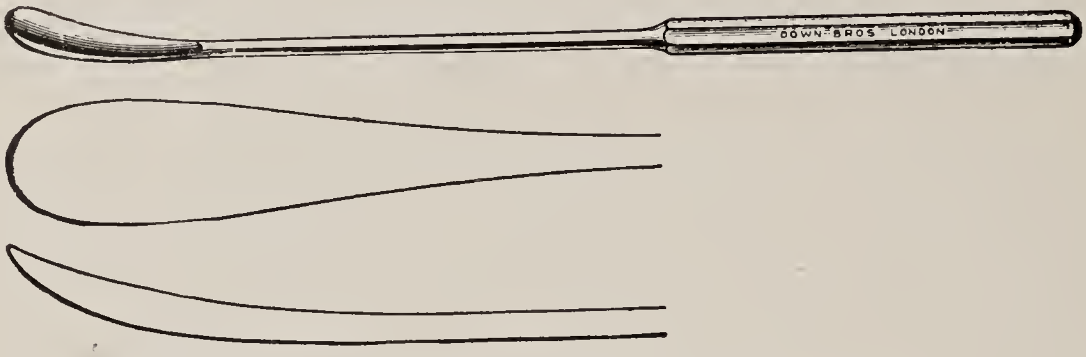


Fig. 149. Author's Gall-stone Scoop.

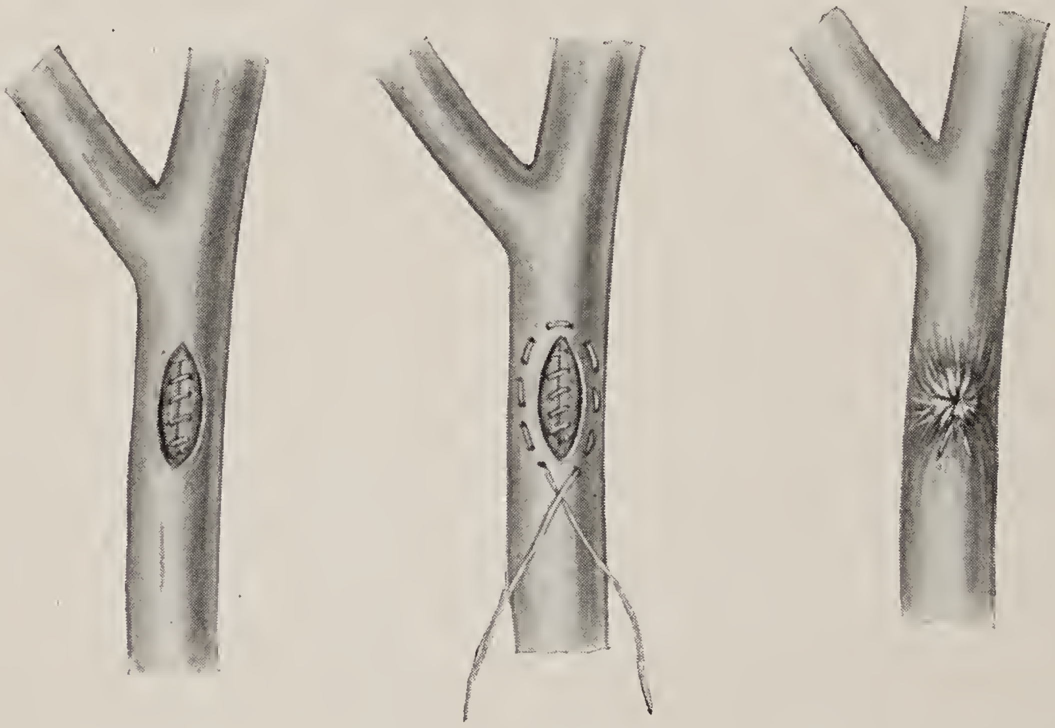


Fig. 150. Diagram to show the Method of Incision and Suture of the Common Bile Duct.

Although there is seldom any fear of leakage, yet, where the ducts have been incised and extensive adhesions separated, there is usually some tendency to pouring out of fluid in the first few hours. I therefore generally insert a gauze drain through a drainage tube passed into the right kidney pouch, bringing it out through a stab puncture 3 or 4 inches to the right of the chief incision; and through the same stab puncture the tube draining the common duct or gall-bladder is also passed. Dependent drainage is thus obtained and the anterior incision can be securely closed. This drain is usually removed within forty-eight hours.

When the patient is thin, by adopting the methods I have suggested the common duct is actually level with the surface; and even in a stout patient the common duct is made easy of access, so that the operation may generally be completed in from thirty to forty minutes where adhesions do not give unusual trouble.

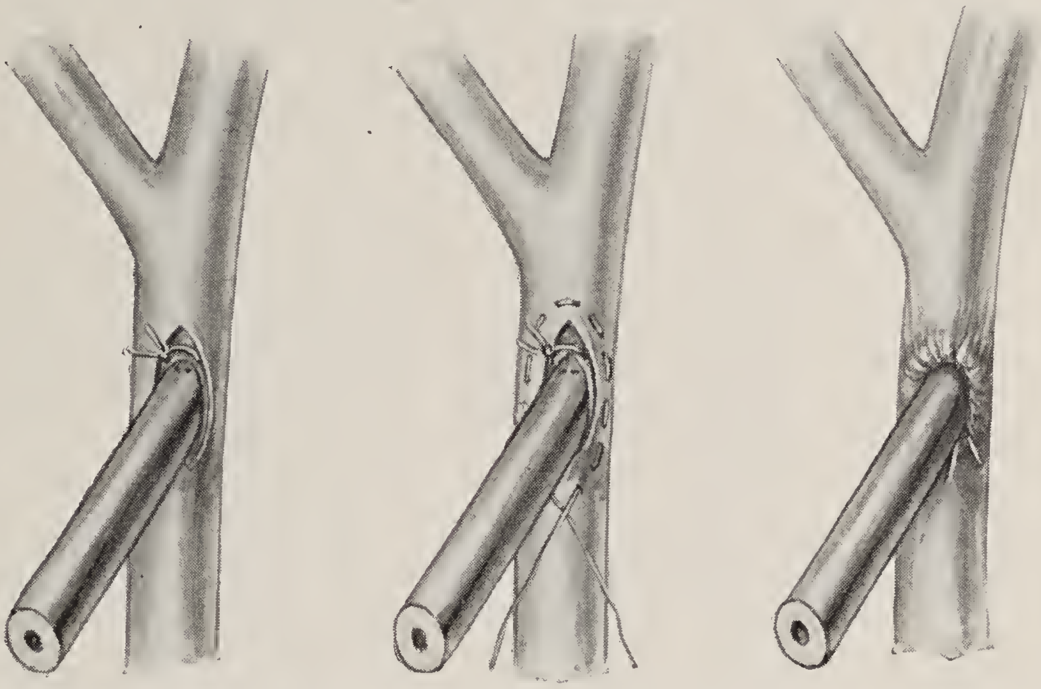


FIG. 151. DIAGRAM TO SHOW THE METHOD OF DRAINING THE COMMON BILE DUCT.

It is of the utmost importance that the ducts should be cleared of all concretions or the operation will be futile, as shown by Kehr, who stated that he had left concretions behind in 16.6% of his cases and by Riedel, Fenger, Lauenstein, Küster, and others. It is important, therefore, after the ducts have apparently been cleared by the scoop, that a finger should be introduced through the incision into the common duct in order that it may be made quite clear that no concretions remain. If for any reason this is not convenient, a careful palpation of the outside of the duct at the time that the probe has been passed into the duodenum and is still in position, will enable the duct to be thoroughly palpated from the outside.

Where there are numerous floating gall-stones in the common duct it is most important that the scoop should be passed into both primary hepatic ducts, as on several occasions I have brought down calculi which otherwise it would have been impossible to discover.

Should there be any difficulty in closing the common duct after choledochotomy owing to the grave condition of the patient or from anæsthetic difficulties, it may be borne in mind that a simple drainage of the right kidney pouch through a dependent opening has occasionally answered all requirements; but this method is not to be recommended as the rule, as it is fraught with danger of general infection of the peritoneum.

Results. Choledochotomy, which has frequently to be performed under such unfavourable conditions as the presence of deep jaundice, infective or suppurative cholangitis, and other complications associated with the presence of gall-stones in the common duct, must always be an operation attended with danger, especially in the hands of inexperienced operators; though since the introduction of improved methods the mortality has been considerably reduced. Although I have had a series of fifty-three choledochotomies without a death, the total mortality of my cases since 1899 has been 5.1%. It should not exceed 5%, and in the 1907 *Report of the Rochester Clinic* out of fifty-two cases there was only one death, a mortality of 1.9%.

The division of choledochotomies into complicated and uncomplicated is open to serious objection, as practically all cases of common duct cholelithiasis have some complication, hence my statistics are based on every case in which the operation has been performed.

MODIFICATIONS OF CHOLEDOCHOTOMY

Various modifications of the ordinary operation of choledochotomy may have to be practised under certain conditions; for instance, if the patient be extremely ill and the adhesions are such that their separation would involve a great expenditure of time with consequent shock to the patient, it may sometimes be possible to make the right side of the common duct prominent by passing the fingers of the left hand above the stomach and pressing the duct outwards at the same time that the thumb presses inwards the tissues superficial to the duct, thus rotating the parts within the grasp of the hand and rendering prominent the common duct.

A gall-stone in the common duct will now be made prominent and can be readily cut down on and removed; the duct being afterwards explored and drained as described in the ordinary operation of choledochotomy. In a case of this nature it will probably be desirable to spend very little time over suturing the duct, and as the adhesions will assist in preventing extravasation of bile, the surgeon may be content to trust to drainage of the right kidney pouch by passing a large drainage tube through a stab wound at the most dependent part. If, however, time permits, the tube may be fixed in by suture and the duct closed around it.

DUODENO-CHOLEDOCHOTOMY

If a gall-stone be impacted in the pancreatic portion of the common duct or in the ampulla of Vater and it is found impracticable to press it onwards into the duodenum or upwards into the first part of the duct, the removal of the gall-stone may be effected through the opened duodenum. The operation is known as duodeno-choledochotomy if the stone is extracted through the papilla either by dilating or incising it, or as transduodenal choledochotomy if the pancreatic portion of the common bile duct has to be incised through the posterior wall of the duodenum. To the former operation McBurney's name is attached, to the latter Kocher's.

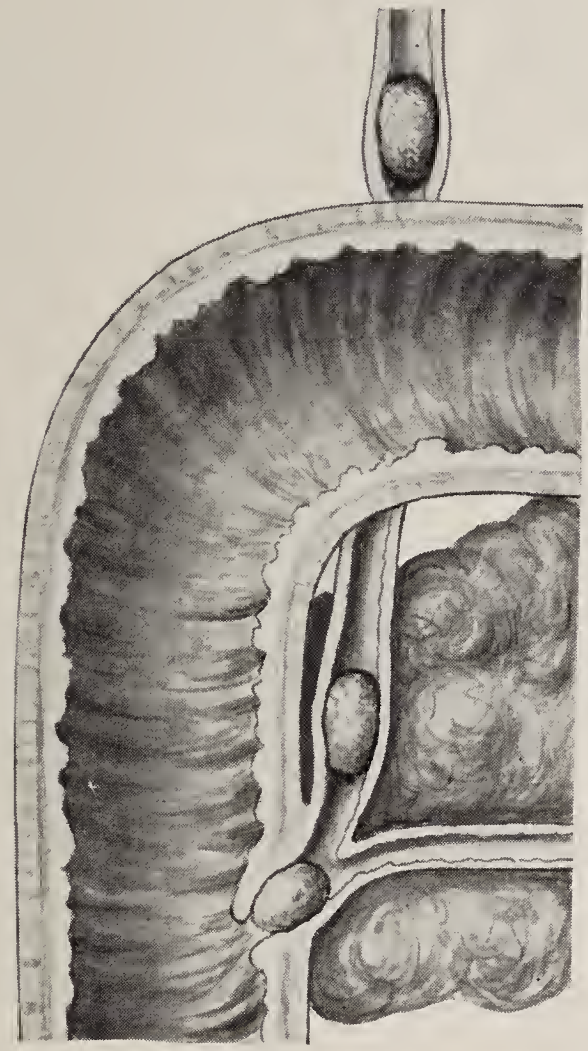


Fig. 152. Diagram showing Gall-stones in the Supraduodenal and Pancreatic Portions of the Common Duct and also in the Ampulla of Vater.

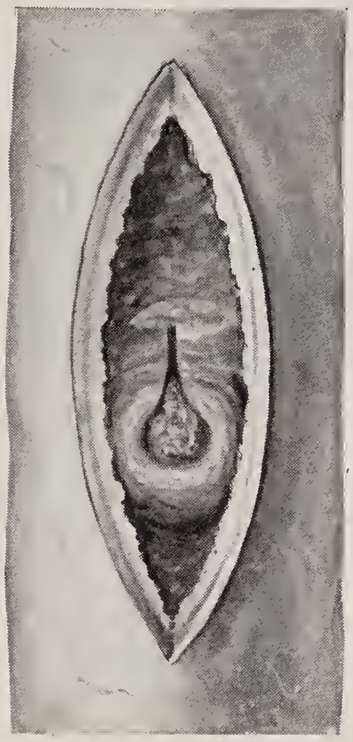


Fig. 153. Duodeno-choledochotomy. McBurney's operation.

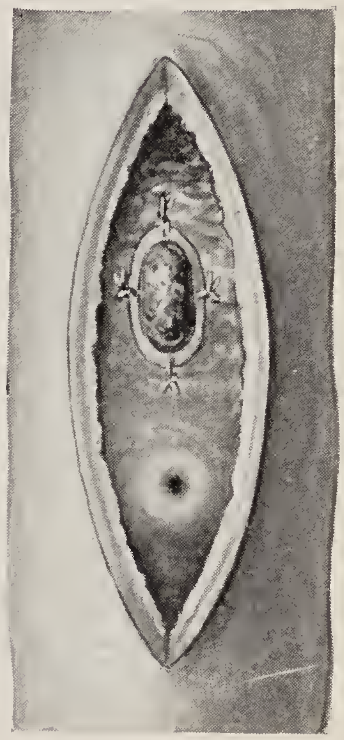


Fig. 154. Transduodenal Choledochotomy. Kocher's operation.

The operation through the duodenum is much simplified by mobilizing the duodenum (Kocher), which is effected by dividing the peritoneum vertically as it passes outwards from the duodenum over the front of the right kidney and by stripping the peritoneum inwards from the kidney until the duodenum is reached. The duodenum and the head of the pancreas are thus rendered so mobile that they may be lifted forward and easily manipulated.

The duodenum having been mobilized is drawn forwards and held at the surface of the wound by the left thumb and forefinger. Gauze swabs are now packed around it so as to avoid soiling of the wound when the intestine is opened. A vertical incision of about an inch is made through the front wall of the second part of the duodenum, which exposes the papilla on the posterior wall, the termination of the common bile duct being rendered more distinct by the bulging gall-stone. Bile or intestinal fluid is carefully mopped up. If a concretion is impacted in the ampulla of Vater it will necessarily be small, and can be readily removed after dilating the orifice by introducing the blades of a pair of dressing forceps closed and afterwards expanding them, or the papilla may be incised over a director or by cutting down directly on to the concretion. Through the widely open papilla a gall-stone scoop can be passed up the duct so as to clear out any other gall-stones or débris that may be present.

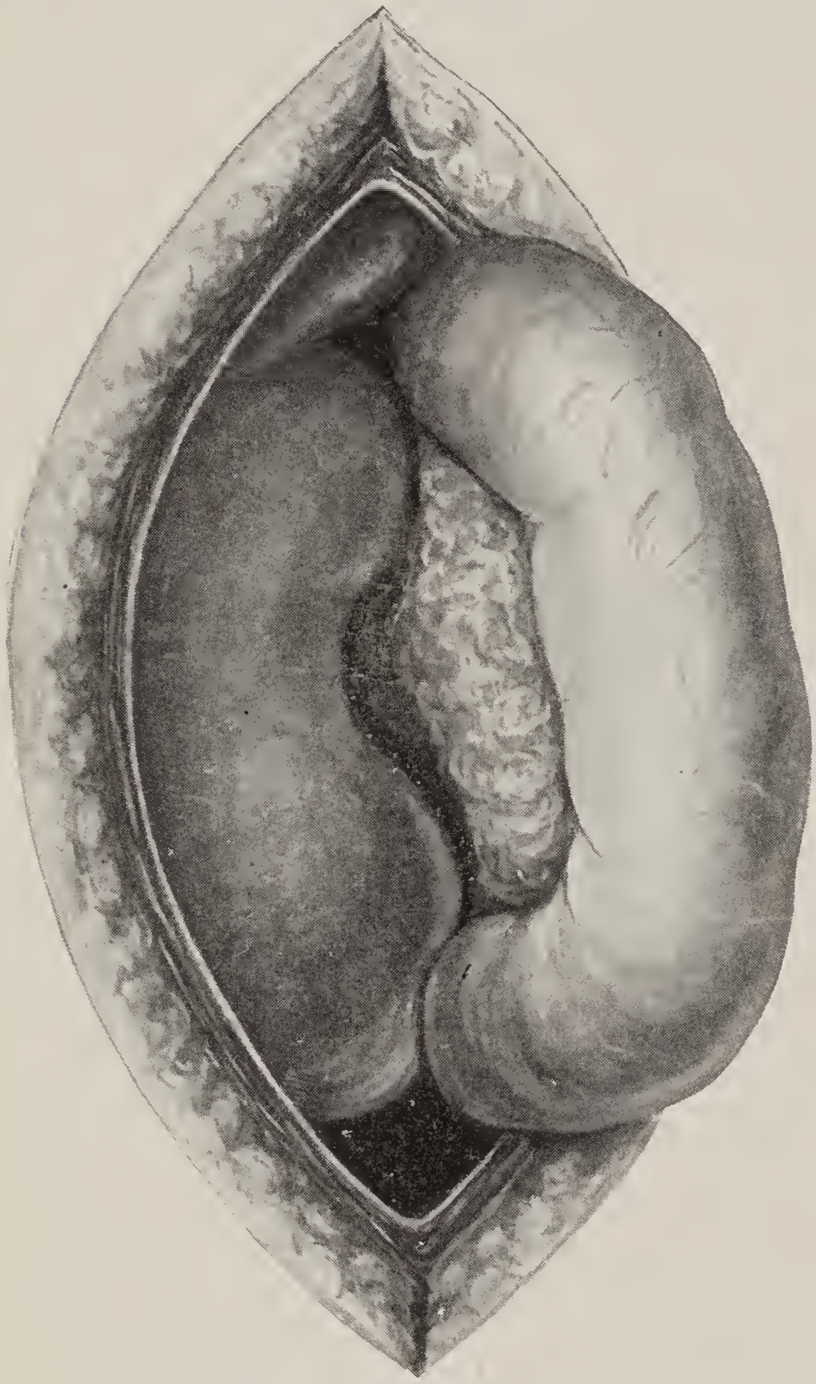


Fig. 155. Drawing to show Mobilization of the Duodenum.

Rarely it is possible, when the papilla is exposed, to squeeze the gall-stone into the duodenum without incising or dilating the papilla. This I have found practicable on two occasions (see Fig. 156).

If the impacted stone be large it may be impacted in the pancreatic portion of the common duct, in which case the entire thickness of the posterior wall of the duodenum may require to be incised, and possibly an intervening condensed portion of the head of the pancreas, which in this condition is usually fibrous from past interstitial inflammation.

The incision may be made on to the bulging concretion sufficiently long to permit of the extraction of the gall-stone. The edges of the wound in the common bile duct and of the incision through the posterior wall of the duodenum are caught up together by small volsellæ or nibbed forceps, and one or two sutures of catgut are applied on either side and at the upper and lower angles of the wound in the duct, so as to avoid any danger of extravasation of bile or intestinal contents into the retroperitoneal tissues should they have been accidentally opened up, an accident that actually did occur in one case that I know of. After the application of the sutures the duct is explored by a gall-stone scoop or by the finger in order to ascertain that all concretions have been removed.

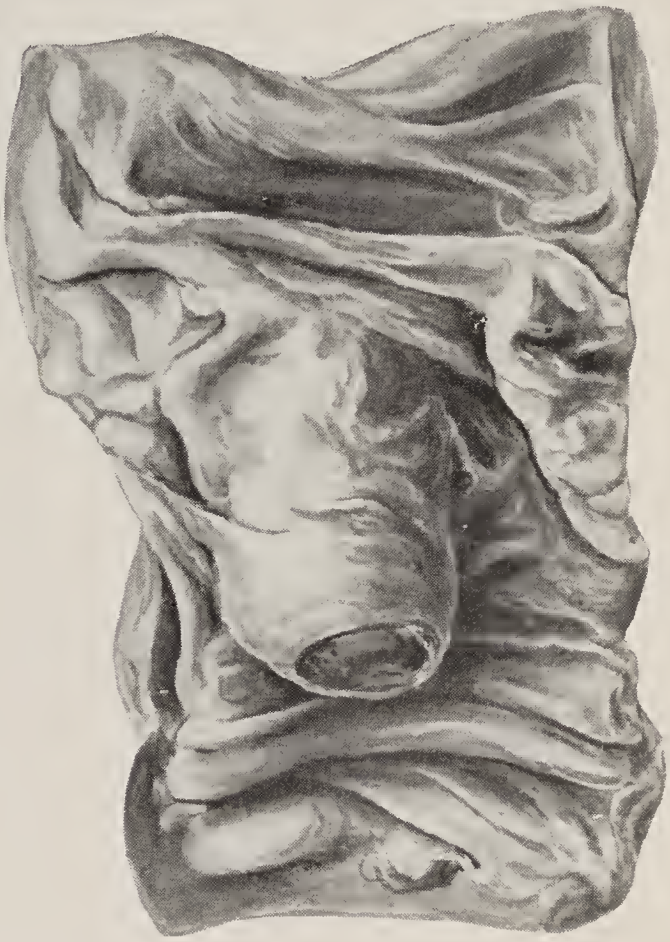


Fig. 156. Gall-stone impacted at Duodenal Papilla. Drawing of Specimen No. 2826, R.C.S. Museum.

When the papilla and adjoining part of the termination of the bile duct are incised I have not thought it necessary to apply sutures in any of my cases. If at the same time that duodeno-choledochotomy has been performed, the first portion of the duct has been opened, it may be advisable, as was first suggested by Kehr, to insert a strip of gauze into the upper opening and by means of long slender forceps to drag it downwards through the papilla, thus sweeping the lower part of the common duct clear of all débris.

RETRODUODENAL CHOLEDOCHOTOMY

This operation was described by Haasler in 1898 for reaching a calculus impacted in the pancreatic portion of the common duct.

As, in an experience of nearly 200 cases of choledochotomy, I have yet to meet with a case in which I could not move the calculus backwards to the first portion of the duct, whence it could be removed, or reach it from below after laying open the papilla, I cannot see the necessity of this modification of the operation of choledochotomy.

Should it be thought necessary to perform the operation, the duodenum must be mobilized by incising the peritoneum an inch or more external to the second part of the bowel, and after reflecting the serous membrane inwards the duodenum may be turned over, exposing the posterior surface of the head of the pancreas and the pancreatic portion of the common duct, which in 62% of cases passes through the substance of the pancreas. The pancreatic portion of the common duct is then incised, and if needful the portion of pancreas overlying it may be safely cut through, as it is usually fibrosed from the irritation of the concretion having set up interstitial pancreatitis.

After the stone has been removed and the duct cleared, the edges of the incision into it must be closed by catgut sutures and the duodenum replaced. Drainage of the retroperitoneal operation area is of vital importance, as extravasation of bile may occur, since the duct in this situation has no peritoneal cover.

CHOLEDOCHOSTOMY

Choledochostomy is the term applied to the direct surface drainage of a dilated common bile duct, an operation frequently performed as part of the technique of choledochotomy, in which class of cases it is very successful. The name is, however, usually reserved for a more serious class of cases in which the common duct has become cystic.

In certain cases the common bile duct becomes dilated into a large cyst capable of holding even up to several pints of fluid, and this may or may not be associated with a considerable dilatation of the gall-bladder.

In one of my cases the condition gave rise to the suspicion of a pancreatic cyst associated with a distended gall-bladder, a mistake in diagnosis which happens to have been frequently made in such cases. The cause of the condition is somewhat obscure, it being more frequently due to a kink in the common duct than to obstruction from a gall-stone or a stricture. Simple drainage of such a cyst is known as choledochostomy, an operation seldom completely successful, since it is apt to be followed by a biliary fistula or to prove fatal from sepsis or exhaustion.

The technique of the operation differs in no way from that described under simple cholecystotomy. The cyst is first emptied by an aspirator, then explored to remove any cause of obstruction if a removable one be found. Through the opening in the cyst a drainage tube is inserted and sutured in position. The edges of the opening in the cyst are then sutured to the aponeurosis by three or four catgut sutures, the operation being completed as described on p. 287.

Choledochostomy, if performed on a common bile duct only moderately distended, for some obstruction in the lower part of the duct or in the head of the pancreas, which it is impossible to remove, is equally unsatisfactory, as the permanent biliary fistula resulting is no less distressing than dangerous; since, even if septic complications do not supervene, the alternative issue is a steady loss of flesh and strength until some intercurrent ailment brings on a fatal ending.

This operation is, therefore, to be avoided, if it be in any way possible to remove the obstruction or to short-circuit it by the operation next to be described.

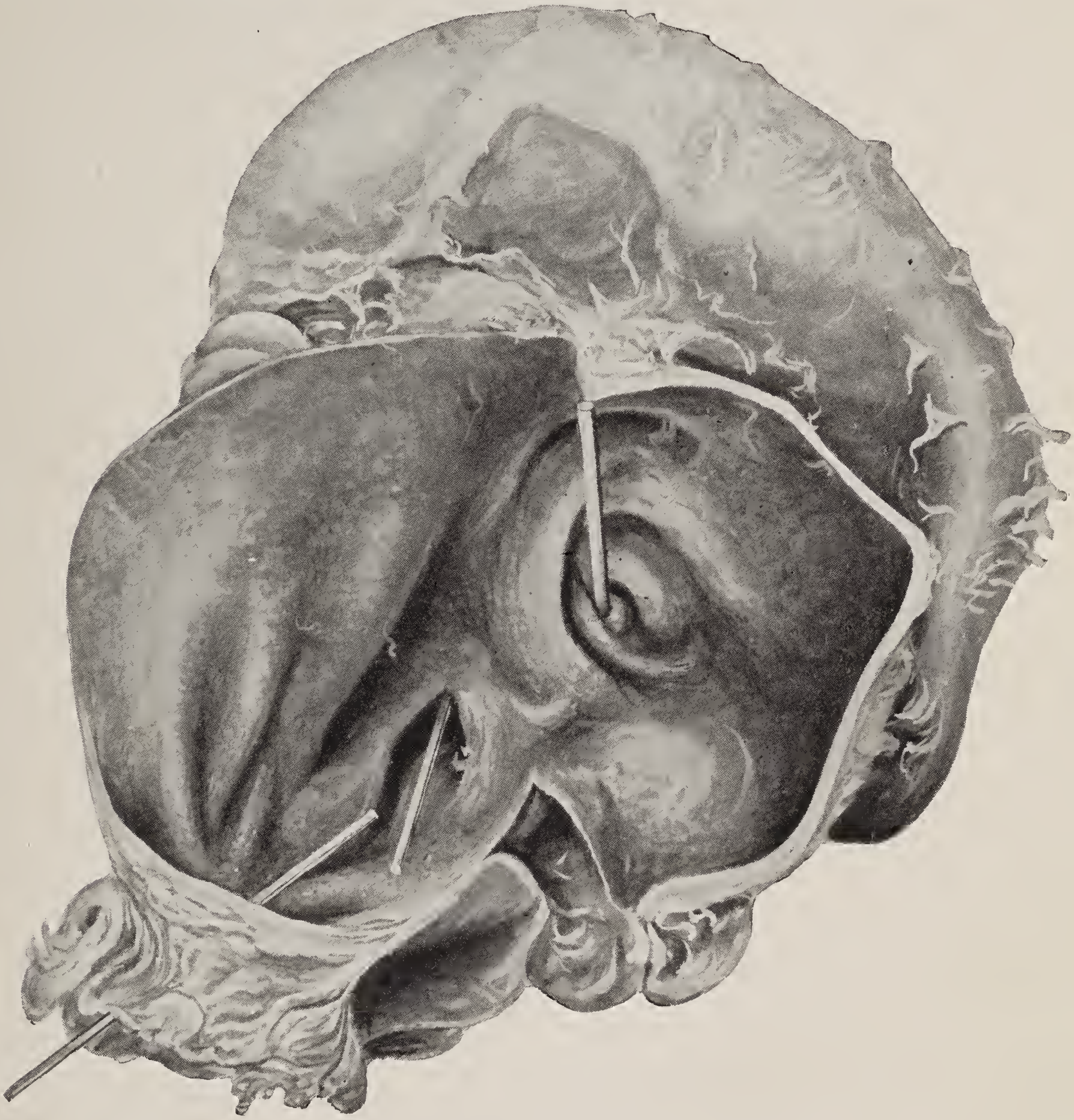


FIG. 157. ENORMOUS DILATATION OF COMMON BILE DUCT.
Drawing of Specimen No. 1419, Guy's Museum.

In a case of my own, although the patient recovered after a choledochostomy, a biliary fistula resulted and choledochenterostomy had to be performed before a cure was effected.

Specimen No. 1419, Guy's museum (see Fig. 157), shows a dilatation of the common bile duct. There is a thick-walled cyst 6 inches across, representing the common bile duct; the portion of duct below this is of less than the normal calibre, and has a valvular fold, which completely obstructs the lumen. The tumour was aspirated twice, 3½ pints of bile being withdrawn on each occasion without relief. Then choledochostomy was performed and death ensued two days after.

CHOLEDOCHENTEROSTOMY

This operation, which has for its purpose the short-circuiting of an irremovable obstruction in the lower end of the common duct, consists in uniting the common bile duct to some portion of the intestine, preferably the duodenum.

For this purpose the duodenum may be mobilized by dividing the peritoneum vertically an inch or more external to its reflection from the bowel on to the front of the right kidney. By stripping the peritoneum the duodenum is reached, and it can then be easily drawn forwards and if needful upwards, and made to reach the supraduodenal portion of the common duct.

If the common duct be hugely dilated, as in the cystic condition previously described, there is no difficulty in bringing it down to meet the duodenum.

The curved clamp-forceps shown in Fig. 141 can now be applied to the duodenum, and, if the common duct is largely dilated, a clamp can also be placed on that portion of the duct selected for the anastomosis. The two portions to be anastomosed can now be placed in apposition, and an opening of ¾ inch must be made into the viscera to be anastomosed, the union being made by two continuous sutures, one serous suture of Pagenstecher's thread being used for the peritoneal surfaces, another of fine chromic catgut being employed to take up and join the whole thickness of the margins of the two visceral incisions; the anastomosis being carried out in the manner described under cholecystenterostomy (see Figs. 142 and 143, p. 306).

If, on account of adhesions or for other reasons, the duodenum cannot be utilized for the anastomosis, a loop of jejunum about 20 inches from the duodeno-jejunal flexure may be brought up and used to make the intestinal anastomosis; but in this case it will be advisable to make, in addition, an entero-anastomosis as shown in Fig. 147, p. 309, so as to avoid the chance of intestinal obstruction from kinking of the jejunal loop.

A case on which I operated, and which is fully described in my work, *Diseases of the Gall-bladder and Bile Ducts,* illustrates the failure of choledochostomy and the complete success of choledochenterostomy.

CYSTODOCHENTEROSTOMY

Cystodochenterostomy is the name applied to the operation of uniting the cystic duct to the intestine. It can be performed without serious difficulty when the cystic duct is dilated, and is even feasible with a duct of normal calibre (see Fig. 140, p. 304). It has for its purpose the short-circuiting of an obstruction in the common duct when the gall-bladder has been destroyed by disease or cholecystectomy has rendered cholecystenterostomy impossible.

In some cases it may be performed to save surface drainage of the duct after removal of the gall-bladder, and in such cases, when long-continued drainage is required, as in interstitial pancreatitis causing obstruction, the operation is a very useful one.

The union of the duct to the duodenum may be effected by means of the decalcified bone bobbin or by simple suture. I have employed each of these methods, but I prefer now to use a double continuous suture, as described under cholecystenterostomy.

If needful, the duodenum may be mobilized, as it makes the operation easier, but if the cystic duct be cut across near the gall-bladder there will be sufficient length of duct to enable the anastomosis to be made without interfering with the peritoneal attachment of the bowel.

CHOLEDOCHECTOMY

A portion of the common duct may require to be removed for new growth or for stricture or for serious damage from gall-stone obstruction.

In one case Doyen excised the damaged portion of the duct and completed the operation by joining the two ends of the duct completely without drainage.

In another case Kehr excised a stricture of the common duct, joined the upper to the lower portion along the posterior margin, and drained the part left unjoined at the front.

Halsted, Mayo, and Moynihan have excised tumours of the common duct and have subsequently united the open ends of the duct by suture, leaving the anterior part open for drainage, or have ligatured both ends of the cut duct and then anastomosed the gall-bladder to the duodenum so as to make a new passage for the bile.

For stricture or injury due to gall-stones this operation may be both immediately successful and ultimately lead to perfect recovery.

For malignant growth in the common duct the occasion can be only rare in which the growth is caught at a sufficiently early stage to render the operation worthy of being attempted. In the cases that have been reported the relief has been of a temporary character, but so marked as to have made the operation worth doing.

PLASTIC OPERATION UPON THE BILE DUCTS

In a case of stricture of the cystic duct in which I did not think it desirable to excise the gall-bladder, I laid open the stricture and united the margins of the vertical incision transversely after the principle suggested by Mikulicz in pyloroplasty, and in a case of stricture of the common bile duct Mr. Moynihan performed a similar plastic operation.

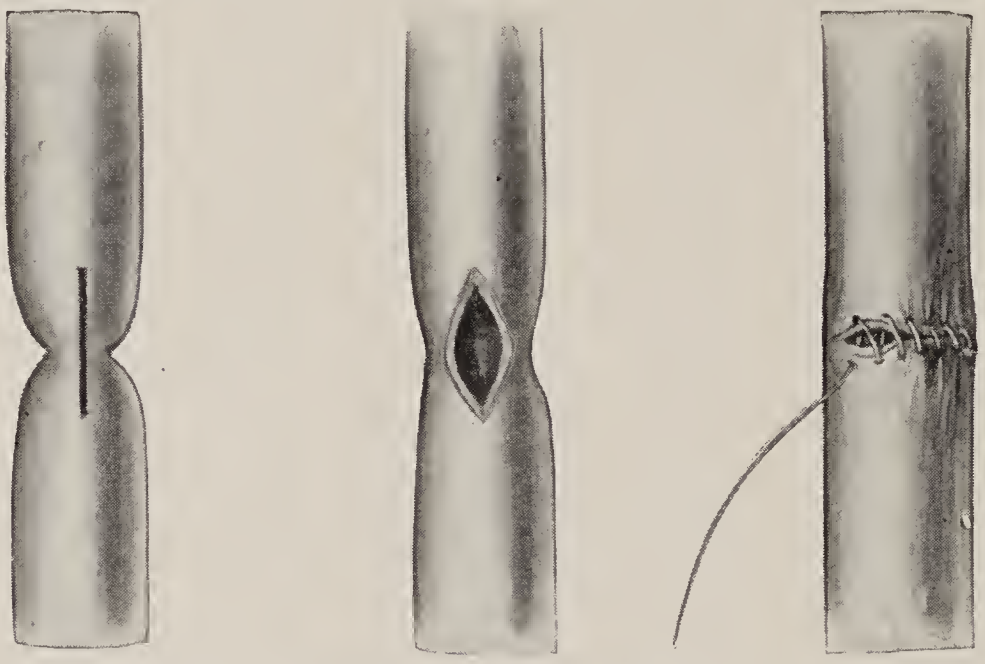


FIG. 158. PLASTIC OPERATION FOR STRICTURE OF THE BILE DUCT.

Kehr repaired a rent with loss of substance in the common duct by turning up a sero-muscular flap from the pyloric end of the stomach.

OPERATIONS UPON THE HEPATIC DUCT

Hepaticotomy. The hepatic duct is frequently drained as part of the operation of choledochotomy, the tube being introduced through the incision of the common duct and passed upwards into the hepatic duct.

Gall-stones are also frequently removed from the hepatic duct through an incision in the common duct, this being effected either by 'milking' the stones downwards to the choledochotomy opening or more frequently by bringing them down by means of the gall-stone scoop. When the common duct is dilated, the hepatic duct practically always participates in the dilatation, and when a choledochotomy opening is made, it is as a rule easy to insert the finger and pass it up to the primary division of the hepatic duct; but by means of the scoop both primary divisions of the hepatic duct can also be explored.

This procedure is of vital importance in all cases of common duct cholelithiasis, as on many occasions when there was every appearance of the ducts having been cleared I have found one or more gall-stones hidden in the upper reaches of the hepatic ducts and have been able to remove them. Some of these cases have been reported in my work on *Diseases of the Gall-bladder and Bile Ducts,* 3rd edit., and others I have not yet reported.

But besides these floating stones it occasionally happens that a large calculus becomes impacted in the hepatic duct, and it is then necessary to incise it vertically over the concretion in the same way that the common duct is opened, and after extracting the concretion the duct may be drained or sutured.

This operation I have performed successfully, and it has also been done by other surgeons.

Case 508 in my work, *Diseases of the Gall-bladder and Bile Ducts,* is a description of such a case, in which an impacted stone in the hepatic duct had led to a biliary pulmonary fistula and was cured by hepaticotomy.

Hepatico-lithotripsy. If there is any difficulty in exposing the duct sufficiently to incise it with safety, it may occasionally be possible to crush an impacted calculus in the hepatic duct and to extract the fragments through an incision in the common duct; this operation I have performed with success, but I must confess to a preference for a clean incision and the removal of the concretion where that is possible.

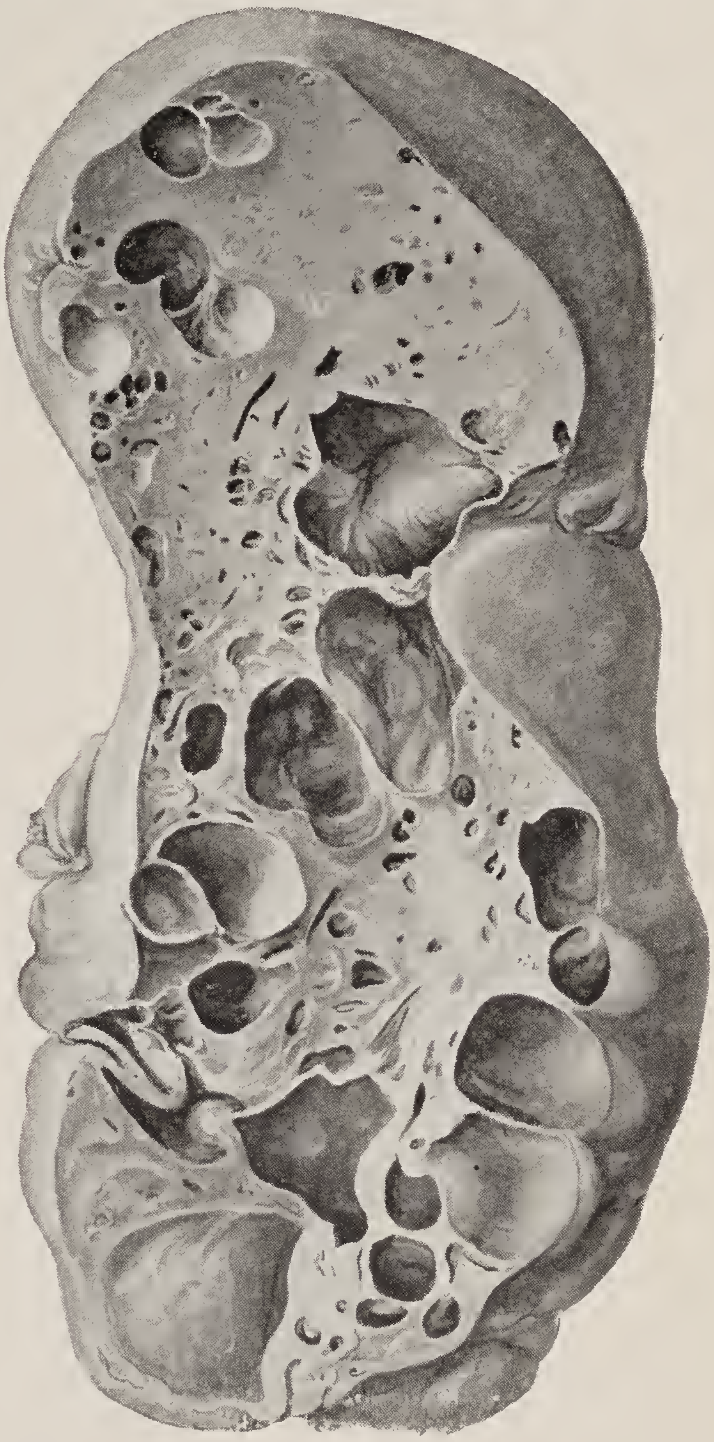


Fig. 159. Cystic Liver due to Dilatation of the Intrahepatic Bile Ducts.

Hepaticostomy. Just as the common bile duct may become enormously dilated apart from the cystic duct, so the hepatic duct outside the liver may be sufficiently dilated to form a distinct tumour, which may be treated by drainage as in a case operated on by Knowsley Thornton in 1888.

A case was described by Leonard Rogers in the *British Medical Journal,* 1903, vol. ii, p. 706, in which a dilated hepatic duct was incised and drained under the impression that it was a dilated gall-bladder. The true condition was shown at autopsy to be caused by an impacted gall-stone.

As shown by a case of Nicolaysen's, such a dilatation of the hepatic duct may occur apart from gall-stone obstruction. In the case of hepaticostomy described by him and proved post mortem, no obvious obstruction was found and he considered the case a congenital deformity.

Transhepatic-hepaticostomy. When it is remembered that gall-stones may form in any part of the biliary apparatus within or outside the liver, it is not surprising that occasionally the ducts within the liver may become obstructed and lead to the formation of a dilated intra-hepatic duct.

I operated on such a case in February, 1891, the patient being a woman, aged 42, who was jaundiced and had suffered from symptoms of gall-stone obstruction. On opening the abdomen, a cyst of the liver was discovered and incised, nearly half a pint of bile-stained mucus and three gall-stones being removed. The cyst was packed with gauze to arrest bleeding and stitched to the surface. The patient recovered.

A case of H. V. Chapman's is recorded (*Abdominal Operations,* B. G. A. Moynihan) in which 480 c.c. of bile-stained fluid and 127 calculi were removed from such a cyst.

Hepato-duodenostomy. In certain cases of obstruction of the common duct from stricture or from actual loss of substance due to operation, in which the cystic duct or gall-bladder is not available for making the anastomosis, it may be desirable to unite the hepatic duct to the duodenum, an operation of considerable difficulty.

In the *Annals of Surgery* for August, 1905, p. 90, is a case reported by Dr. W. J. Mayo, in which, twelve months after a choledochotomy and cholecystectomy, an operation was undertaken for a biliary fistula and the hepatic duct was fixed to the duodenum.

The following description, together with the illustration, is taken from Dr. Mayo's report:—

'A five-inch incision was made just internal to and parallel with the cicatrix of the former wound. A dense tangle of adhesions was encountered, involving transverse colon, duodenum, and stomach, on the one side, and the liver and ducts on the other. By following the remains of the fistulous track carefully and keeping close to the liver, the original drainage opening at the site of the cystic duct was discovered. The hepatic duct was dilated and easily admitted the tip of the index-finger to the primary division. The common duct was reduced by cicatricial contraction to a fibrous cord, along which could be traced a little stain of bile. During the separation of adhesions, it was noted that the duodenum overlapped the remains of the common duct and formed one wall of the fistulous track in its deeper portion. The external incision was continued to the sternal notch and the overlying liver held upwards. The duodenum was still further mobilized. The hepatic duct was freed from its attachment to the fistulous track and from the remains of the common duct; the adhesions posteriorly were not otherwise disturbed, and served a very useful purpose. About 3 inches from the pylorus the duodenum was caught with three catgut sutures and fastened firmly to the adhesions and scar tissue about the hepatic duct, so that it was brought into

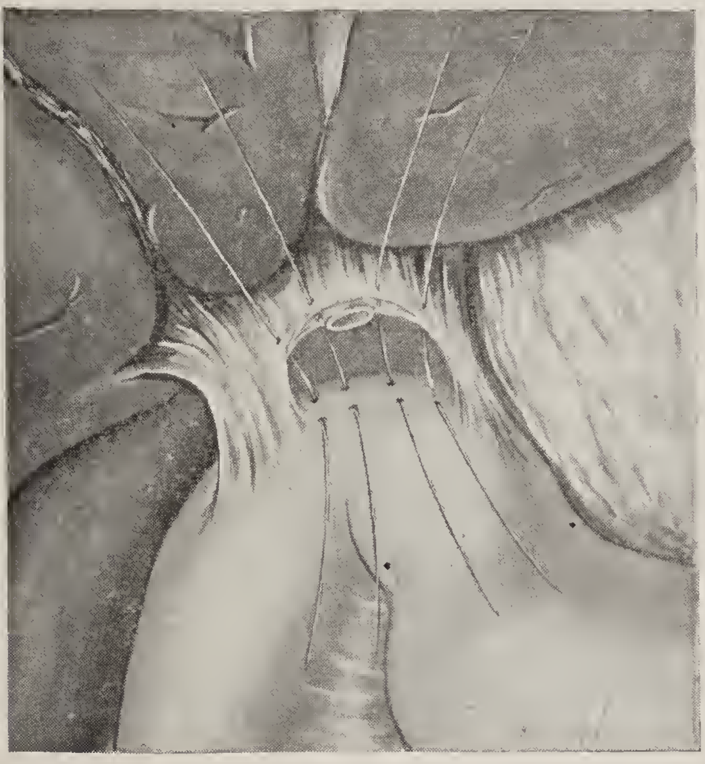


FIG. 160. HEPATO-DUODENOSTOMY. Duodenum sutured to the tissues near the duct. (*Mayo.*)

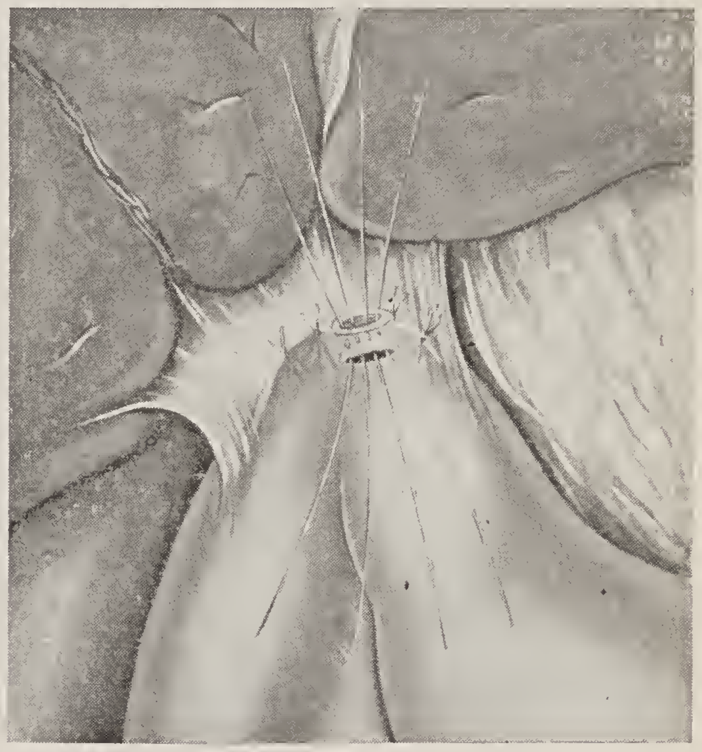


FIG. 161. HEPATO-DUODENOSTOMY. Suture of the duct to the duodenum. (*Mayo.*)

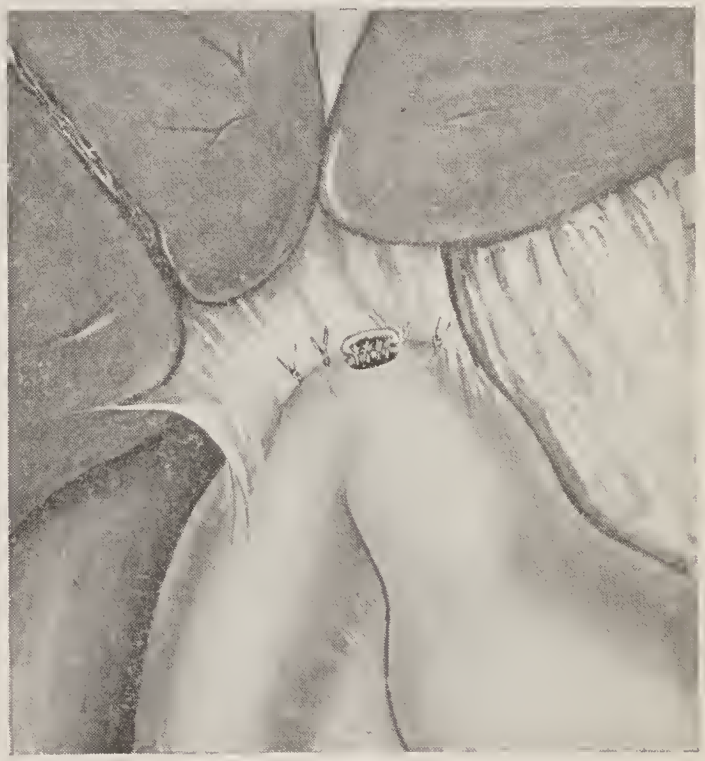


FIG. 162. HEPATO-DUODENOSTOMY. (*Mayo.*)

contact with the end of the piece of all the coats of the hepatic duct. At the point of easy contact, an elliptical piece of all the coats of the duodenum was excised of about the same diameter as the open end of the hepatic duct, and four or five catgut sutures were introduced from the mucous side through all the coats of both duct and intestinal wall. In this way the posterior line of the anastomosis was completed. By alternately placing a suture externally and internally the sides were built up in a similar manner to a two-row intestinal anastomosis, excepting that only the inner row penetrated the duct-wall. At the upper part the few remaining sutures were all placed before they were tied. The duodenum was still further attached laterally and anteriorly to the scar tissue covering the liver and ducts by catgut sutures, making a broad area of attachment. A drain of rolled gutta-percha tissue was placed at the upper angle of the abdominal incision and another at the lower, but each at a considerable distance from the anastomotic suture line. The abdominal incision was then closed. Time of operation, fifty minutes. Patient made an uninterrupted recovery. There was no leakage of any kind; drains were removed on the sixth day; patient discharged on the sixteenth day. Patient, re-examined ten months after the operation (March 22, 1905), had gained 31 pounds in weight and was in excellent health.'

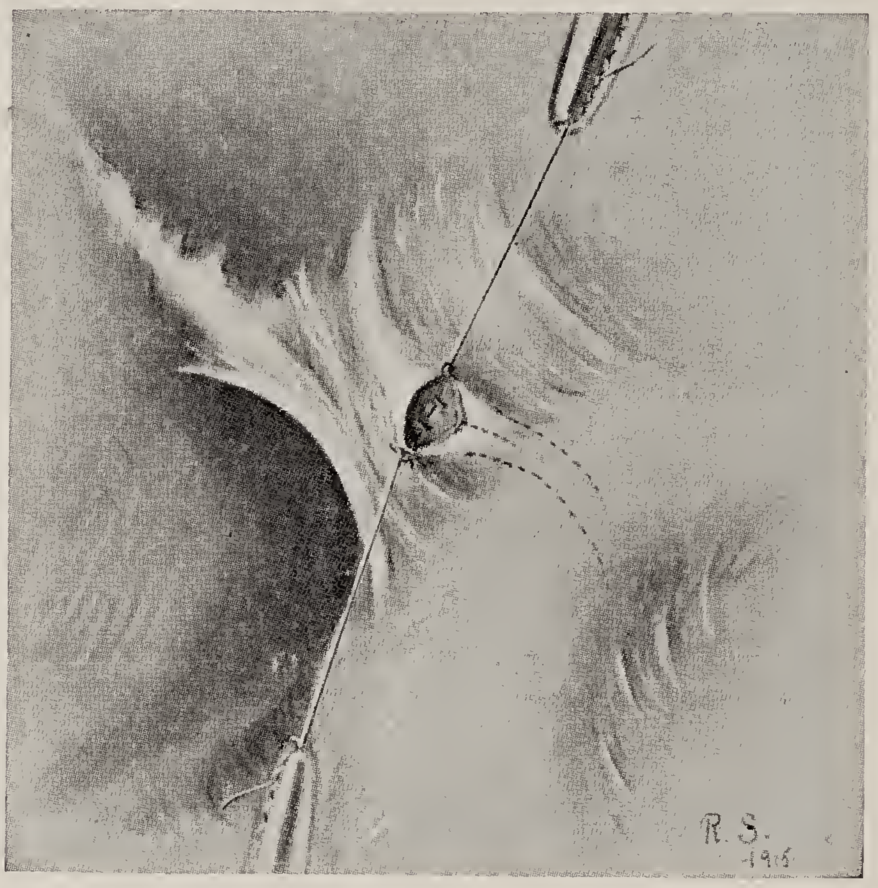


Fig. 163. End of Common and Hepatic Ducts sutured with Through-and-through Chromic Catgut. Dotted line shows where the end of the common duct is enlarged by short longitudinal incision. (*Mayo.*)

REPAIR AND RECONSTRUCTION OF THE HEPATIC AND COMMON BILE DUCTS

Repair of the hepatic and common bile ducts may become necessary because of operative removal incident to resections for malignant growths, stricture following gall-stone injury, or accidental injury during operation. The latter is by far the most common cause of stricture causing complete obstruction. The operations are grave because of accompanying jaundice and debility and the extensive local scar tissue present. For this reason a two-stage operation may be advisable if the patient is highly jaundiced, the first instituting a biliary fistula and the second dealing with the reconstruction of the duct.

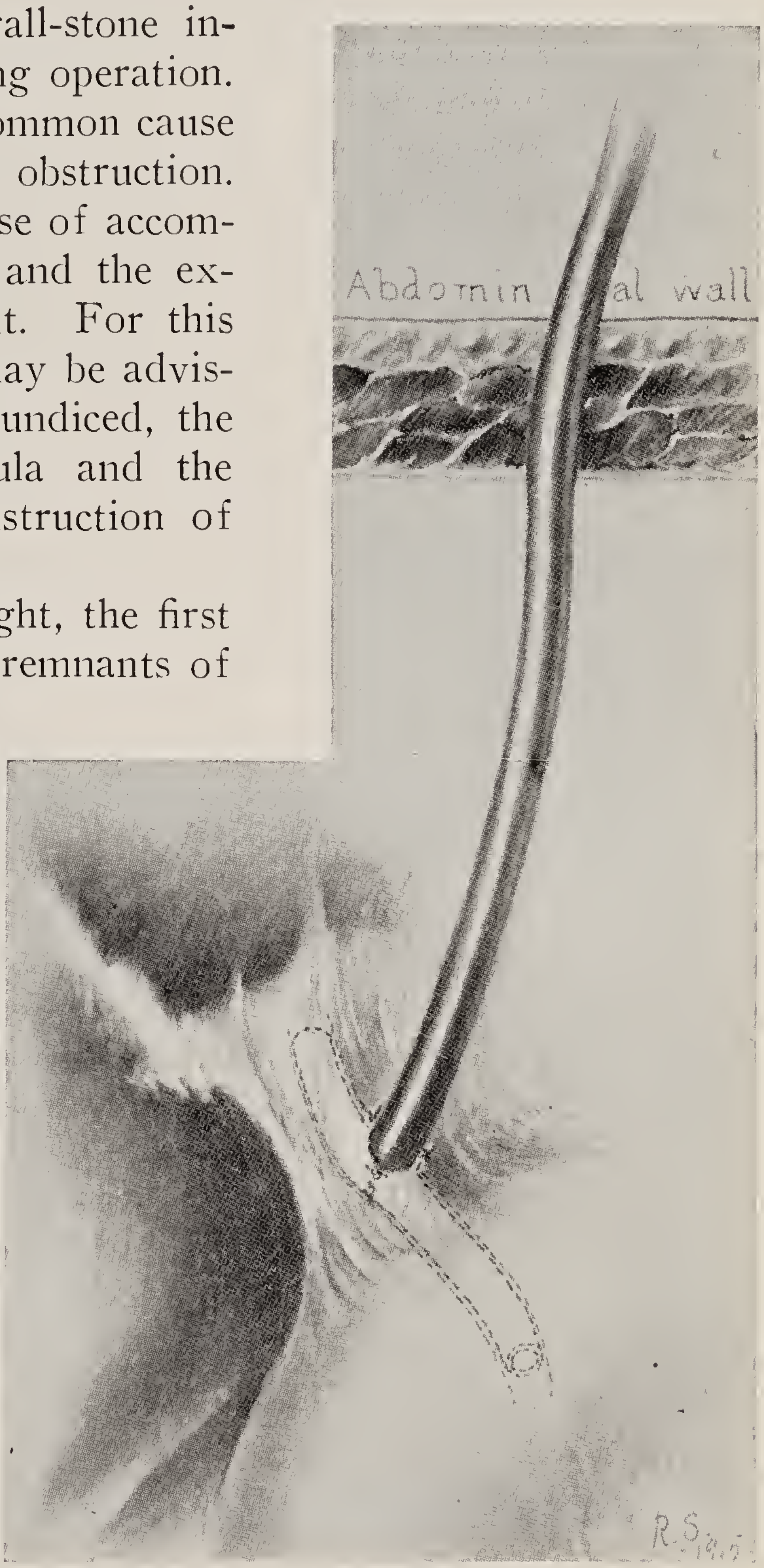
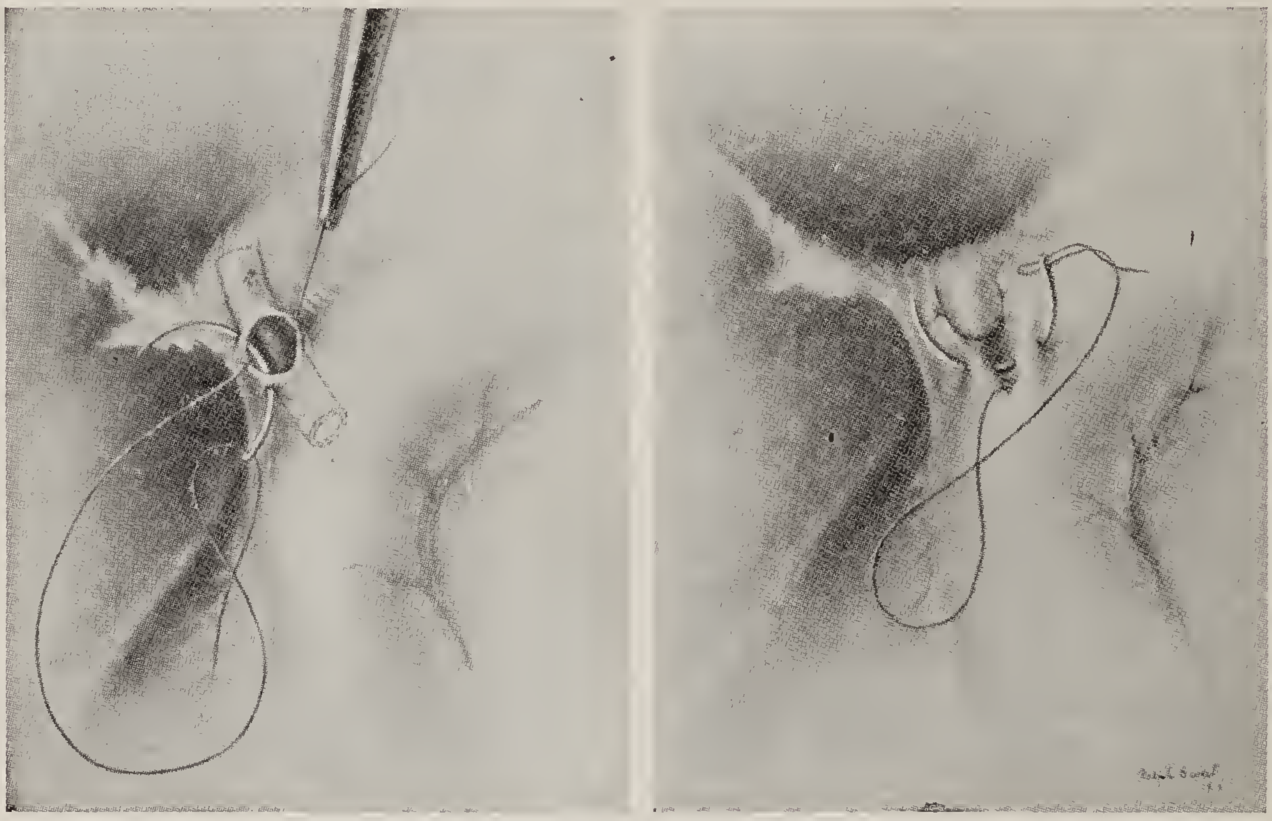


Fig. 164. 'T' Tube in Place. Duct ends sutured about it. (*Mayo.*)

When reconstruction is sought, the first step consists in identifying the remnants of duct. One seeks first the gastro-hepatic omentum with the foramen of Winslow. If this is difficult to find, the operator should follow along under the surface of the liver and the gall-bladder sulcus to the transverse fissure (Eliot). Here the pulsations of the hepatic artery give one a guide to the duct. By cutting the scar tissue from here along the gastro-hepatic ligament one finds the distal end of the duct. In those cases where the stricture is in the pancreatic portion of the duct, the result of ulceration, a pair of dilating forceps may be passed down the duct and the stricture devulsed (Mayo). Where, however, the duct is completely destroyed, various procedures have been used. Where possible, direct end-to-end suture should be used, in other cases anastomosis of the duct to the stomach, duodenum, or jejunum may be feasible, while in a third group some method of plastic repair may be necessary.

End-to-end suture. The two ends being found are dissected free and a few catgut through-and-through sutures are placed so as to unite the duct ends posteriorly (Mayo). The open end of the common duct is split along the anterior surface one-third of an inch, as advised by C. H. Mayo (see Fig. 163). The split in the free border of the common duct increases its calibre to a considerable extent; it is thus more readily coapted to the dilated hepatic duct. A 'T' tube of appropriate size is now introduced, one arm extending about 1 inch into the hepatic duct to the primary division, and the other arm, if possible, through the entire length of the common duct until its free end passes into the duodenum (see Fig. 164). The gap is closed about the 'T' tube with chromic catgut sutures, the tube fastened with an absorbable suture to the hepatic and common ducts, respectively, and the line of union covered by such omental and peritoneal tissues as may be available for the purpose. A few rubber tissue drains are appropriately arranged. If possible gauze should not be introduced in any form down to the line of union, as it tends to the formation of fistulæ. If neces-



A B

Fig. 165. a, Rubber Tube in Place and Fastened by Chromic Catgut Suture to the Hepatic Duct. Anterior layer of chromic catgut continued. b, Duodenum being sutured to enfold anastomosis, the area later to be covered by omentum. (*Mayo.*)

sary, a piece of rubber tubing may be placed in Morison's pouch in the right renal area and carried out through a stab wound in the loin. As a rule, when the 'T' tube is used for reconstructions of the common duct it is not removed for about three weeks, at which time firm union will be established. After either end-to-end suture or suture of the duct to the stomach or gut, it is wise to cover the area with omentum. In either case also the suture may be made over a tube (see Fig. 165).

PLASTIC PROCEDURES AND THE RECONSTRUCTION OF DUCTS

Where there is such destruction of the duct that it cannot be sutured, or so much scar tissue present that the duodenum cannot be mobilized to permit bringing it up to the duct, many methods of reconstruction have been used. The first group of these comprises procedures designed to construct a duct from adjacent mucous lined tissue, as for instance, by the use of the whole gall-bladder (cholecystenterostomy) or the use of parts of the wall in making the duct, or the use of flaps of duodenum (Walton) or stomach (Kehr) for the same purpose. The second group comprises those procedures designed to restore the duct by the use of foreign tissue, such as a rubber tube, or fascial tube, or the two combined.

Cholecystenterostomy can be used but seldom, owing to the cystic duct obliteration which usually accompanies the condition. The use of flaps of intestine is open to the objection that it favours subsequent cholangitis, but it has been used with success (Walton).

The credit for popularizing the use of a rubber tube connecting the end of the duct and the gut belongs to Sullivan, although it has been used by Vollcker, Verhoogen, Kehr, and others in end-to-end duct anastomosis. Upon this as a foundation many variations have developed in technique. Simple use of the tube connecting the two ends depending upon granulation tissue to surround the tube and thus restore continuity is not as satisfactory as some of the plastic procedures developed upon this as a base.

In those cases where the lower end of the duct can be found or the tube passed through the papilla, the duct may be restored by suturing the adjacent peritoneum around the tube and covering it with omentum, or a tube of fascia lata may be used to bridge the defect with or without the rubber tube. In most cases, however, the rubber tube will be found advisable.

After absorption of the holding sutures the tube passes into the gut unless provision be made for withdrawing it through the wound. This may be done by using a 'T' tube with the long arm passing out through the wound or by attaching a silk ligature to the tube for subsequent use in removal. The tube should be left in position for four weeks to favour the development of a mucous membrane lining before removal.

In 9 out of 18 duct restorations collected by Eliot it was necessary to introduce the tube into the duodenum at a site other than the papilla (Sullivan's operation). In this case the danger of leakage or subsequent cholangitis is much increased. The possibility of this is much diminished if the tube is carried into the gut in an oblique manner and the gut folded over after the manner of a Witzel operation. It should also be remembered that the higher the anastomosis is made the less probable is the ascending infection. The tube should be surrounded by peritoneum, fascia, or omentum, and project well into the gut.

The results of hepatostomy are problematical and the condition of the patient generally contra-indicates complicated intestinal exclusions recommended on theoretical grounds.

LUMBAR OPERATIONS UPON THE BILE PASSAGES

Although cholecystotomy, cholecystectomy, and choledochotomy have all been performed through a lumbar incision with success, yet this route has usually been adopted only when a mistake in diagnosis has occurred, such as mistaking a dilated gall-bladder for a cystic kidney, or finding, when exposing a movable kidney, that the gall-bladder is distended owing to obstruction in the ducts and that it can be made to project into the lumbar wound without difficulty. As routine procedures lumbar operations on the bile passages cannot be advised.

UNION OF THE LIVER TO THE DUODENUM

This operation was first suggested and put into practice by Kehr, and has since been advocated by Maylard of Glasgow for cases of permanent obstructive jaundice incapable of relief otherwise. The theory on which it is based is that by opening one or more of the intrahepatic bile ducts and connecting the surface of the wounded liver to the opened duodenum, the obstruction to the flow of bile into the intestine will be short-circuited.

So far no success has attended the few operations that have been done, nor does it seem probable that the operation will be likely to afford sufficient relief to render it worth while undertaking so serious and dangerous a procedure.

CHAPTER IV

OPERATIONS UPON THE PANCREAS

ANATOMICAL CONSIDERATIONS

THE greater part of the pancreas lies in the epigastrium, but a portion of the body and the tail extend into the left hypochondrium, and the head may project into the umbilical region. The organ, a long, pinkish, cream-coloured gland, stretches transversely across the posterior abdominal wall, from the concavity of the duodenum to the lower and inner border of the spleen.

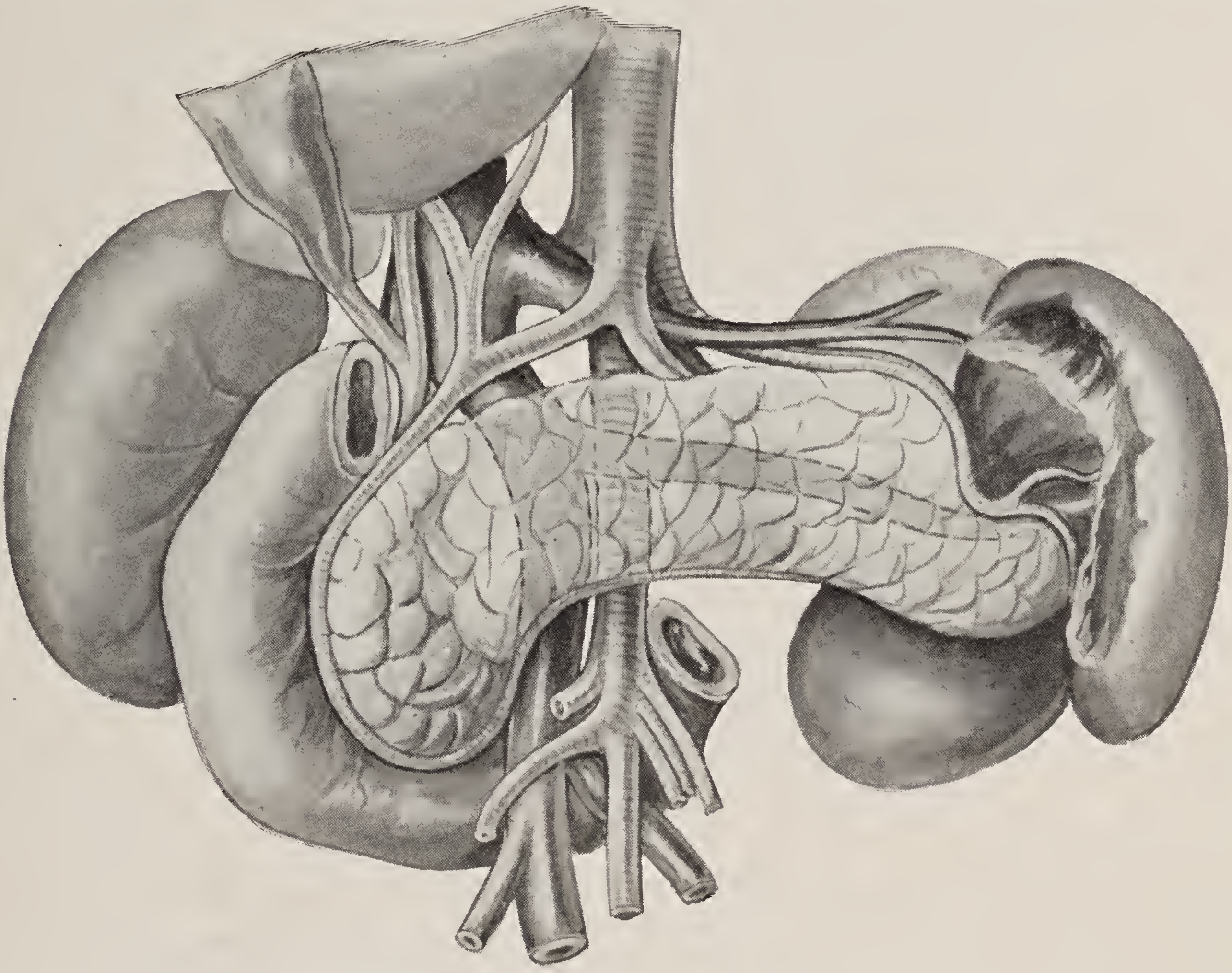


FIG. 166. TO SHOW THE RELATIONS OF THE PANCREAS AND ITS VASCULAR SUPPLY.

The enlarged right extremity, or 'head,' extends downwards and to the left, lying in the concavity of the duodenum in contact with its second and third parts, and opposite to the second and upper part of the third lumbar vertebra. The short and comparatively narrow portion of the gland termed the 'neck' arises from the upper and right part of the head. It runs upwards and to the left, and after a course of about one inch merges into the 'body,' which runs backwards and to the left at the level of the first lumbar vertebra. The pointed left extremity, or 'tail,' is the least firmly attached portion of the organ. It merges so gradually into the body that no sharp line of distinction can be drawn between the two.

The disk-shaped head is separated from the neck by a deep groove, the 'incisura pancreatis.' In this groove lie the superior mesenteric vessels. That portion of the gland which lies to the left of the vessels, along the third part of the duodenum, is termed the 'uncinate process,' and when, as happens occasionally, it is separated from the rest, it is known as the 'lesser pancreas.' Above and to the right, the anterior aspect of the head is in contact with the commencement of the transverse colon. The lower part is covered by peritoneum, reflected from the lower surface of the colon and entering into the formation of the greater sac. The posterior surface of the head is devoid of peritoneum, and is directly applied to the front of the inferior vena cava, the left renal vein, and the aorta. The common bile duct also lies in a groove, or canal, in this surface.

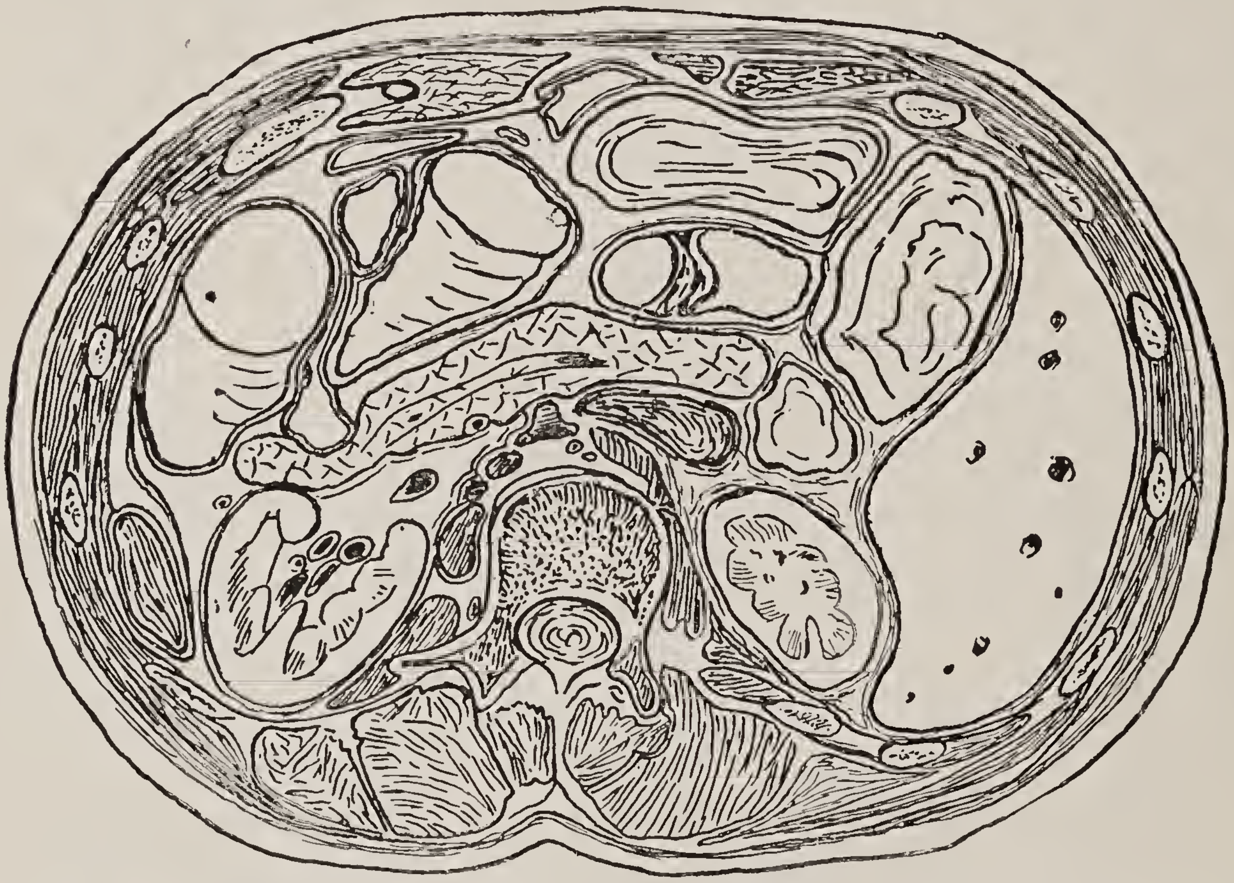


FIG. 167. TRANSVERSE SECTION OF THE ABDOMEN AT THE FIRST LUMBAR VERTEBRA. To show the relations of the pancreas. (*After Braune.*)

The body runs from right to left, and slightly upwards. The anterior surface is separated from the stomach by the lesser sac of the peritoneum, the posterior wall of which is intimately attached to it. At the right extremity, where the body joins the neck, there is often a well-marked prominence, the 'omental tuberosity,' so called from its coming into contact with the small omentum when the stomach is distended. The posterior surface lies upon the aorta, the origin of the superior mesenteric artery, the pillars of the diaphragm, the splenic artery and vein (which run a tortuous course along its upper border in a single channel or maybe two separate grooves), the left kidney and renal vessels, and the left suprarenal capsule. This surface, like the posterior aspect of the head, is devoid of a peritoneal covering. At the full term of pregnancy the uterus rises and comes into contact with the lower border. The middle portion is covered by the jejunum. The whole surface is completely invested by peritoneum, derived from the descending layer of the transverse mesocolon.

The tail comes into contact with the lower part of the inner surface of the spleen.

Peritoneal relations. The transverse mesocolon is attached to a line running along the anterior border of the pancreas from the neck to the tail. The anterior layer passes upwards and backwards, over the superior surface, to form the posterior wall of the lesser sac, the posterior going downwards and backwards along the inferior surface to form the greater sac. At the neck, and on the head, the two sheets of peritoneum have separate lines of attachment so that a somewhat variable area is devoid of a peritoneal covering and is only separated from the colon by areolar tissue. In many cases, however, the transverse mesocolon is continued as far as the hepatic flexure, so that the head and neck receive a complete peritoneal investment. The posterior surface is quite uncovered by peritoneum.

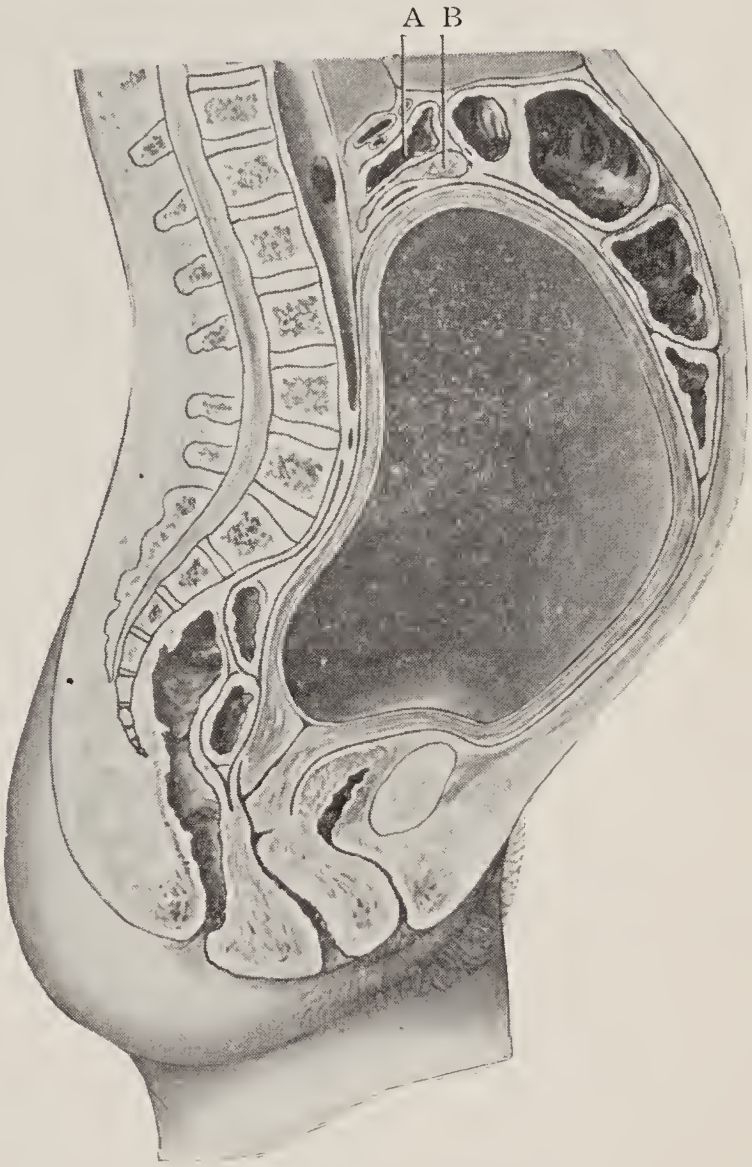


Fig. 168. Vertical Section of the Body at Full Term. Showing the relation of the uterus to the pancreas. A, Duodenum; B, Pancreas. (*After Braune.*)

The relations of the pancreas to the peritoneum are of the utmost importance, both from a surgical and pathological point of view. The retroperitoneal position of the organ explains not only the course taken by pus in some cases of suppurative pancreatitis, upwards to the diaphragm and downwards towards the left iliac fossa, but also how such collections may be reached from the right or left loin, especially the latter, by an incision in the costo-spinal angle, or from the left iliac fossa, or between the ribs, when it has travelled upwards and presents as a subdiaphragmatic abscess.

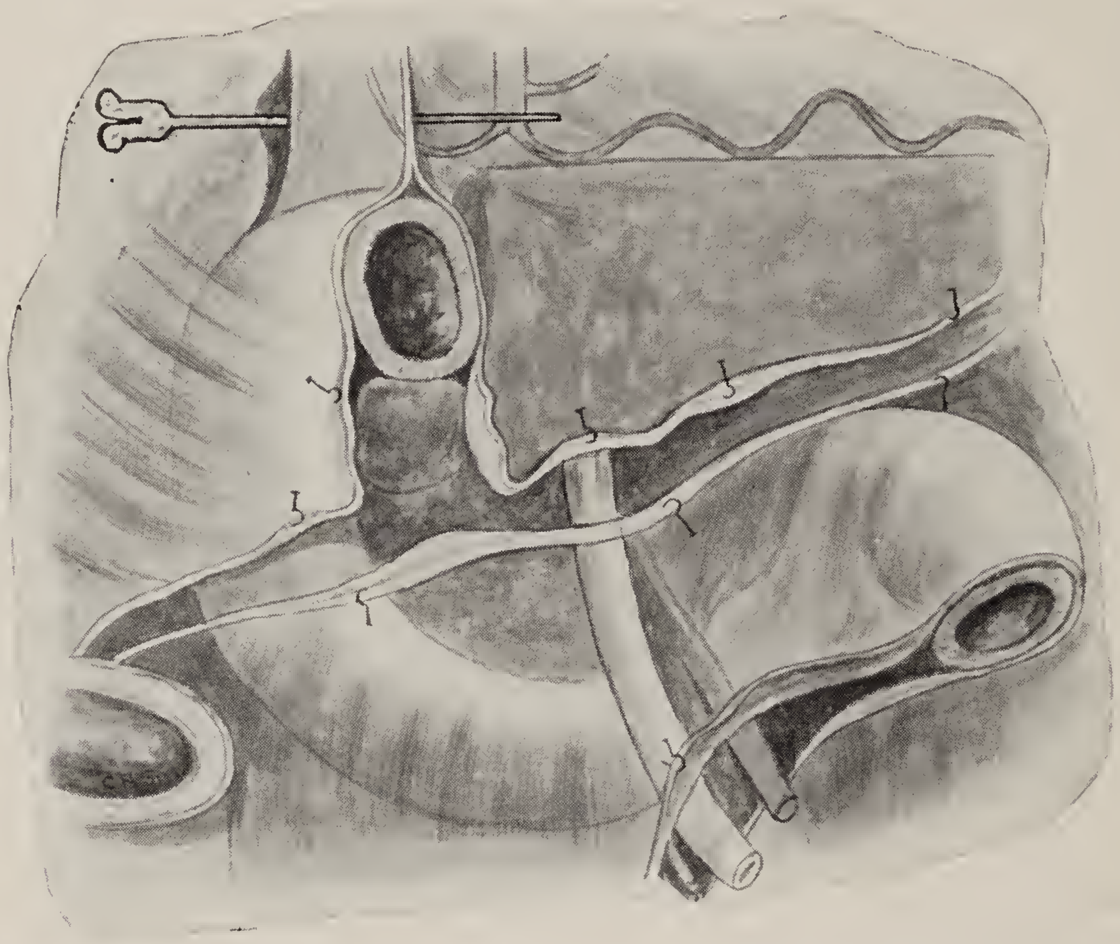


Fig. 169. Diagram to show the Relations of the Peritoneal Reflections of the Pancreas.

The fact that the anterior surface of the pancreas projects into the lesser sac renders it easy to explain how this cavity is invaded in inflammatory affections or injury of the gland, and from its shape it is not difficult to see how, when it is filled with fluid, it is in many instances mistaken for a true pancreatic cyst. The real nature of this variety of pseudo-cyst was demonstrated many years ago by Jordan Lloyd.

Ducts. The pancreas has normally two ducts which open separately into the duodenum. The main duct, or *duct of Wirsung,* commences in the tail by the union of the small tributaries and courses through the body of the gland from left to right. In the neck it alters its course, bending downwards and backwards to reach the head of the organ. In the latter it lies nearer the posterior than the anterior surface, and comes into relation with the common bile duct, beside which it runs to the duodenum. The two ducts pierce the wall of the second part of the duodenum obliquely, about 3 to 4 inches below the pylorus, to open into the lumen of the gut by a common orifice, situated on a papilla-like fold of the mucous membrane called the 'papilla or caruncula major.' Above this there is constantly found a small fold of mucous membrane, which must be raised in order that the caruncle and its orifice may be seen, and running downwards from the caruncle is a small vertical fold

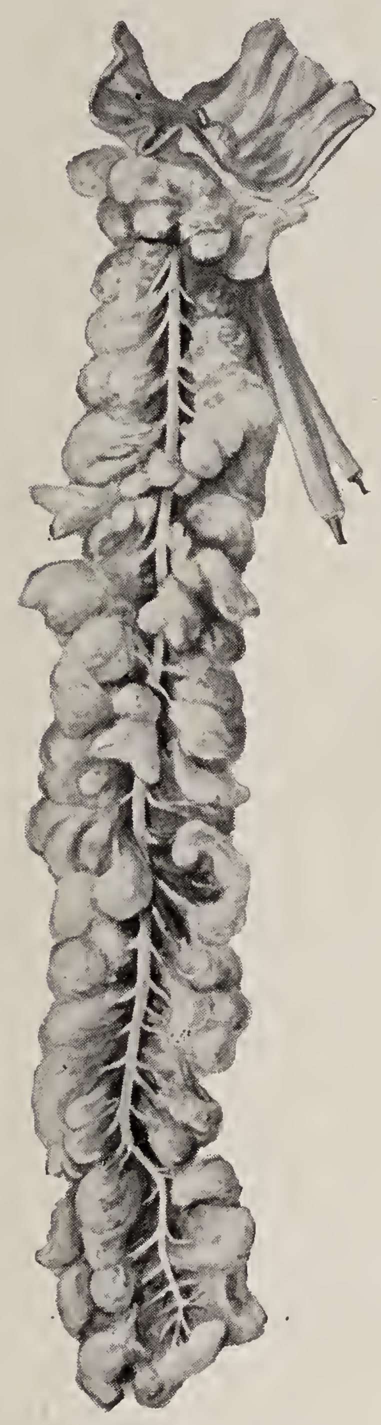


FIG. 170. THE PANCREAS. Drawing of Specimen No. 277, R. C. S. Museum. Shows the separate lobules of the pancreas with their ducts opening into the duct of Wirsung.

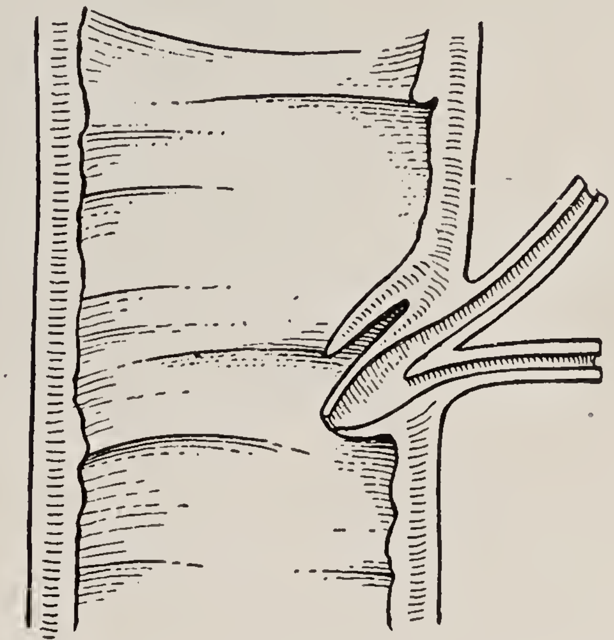
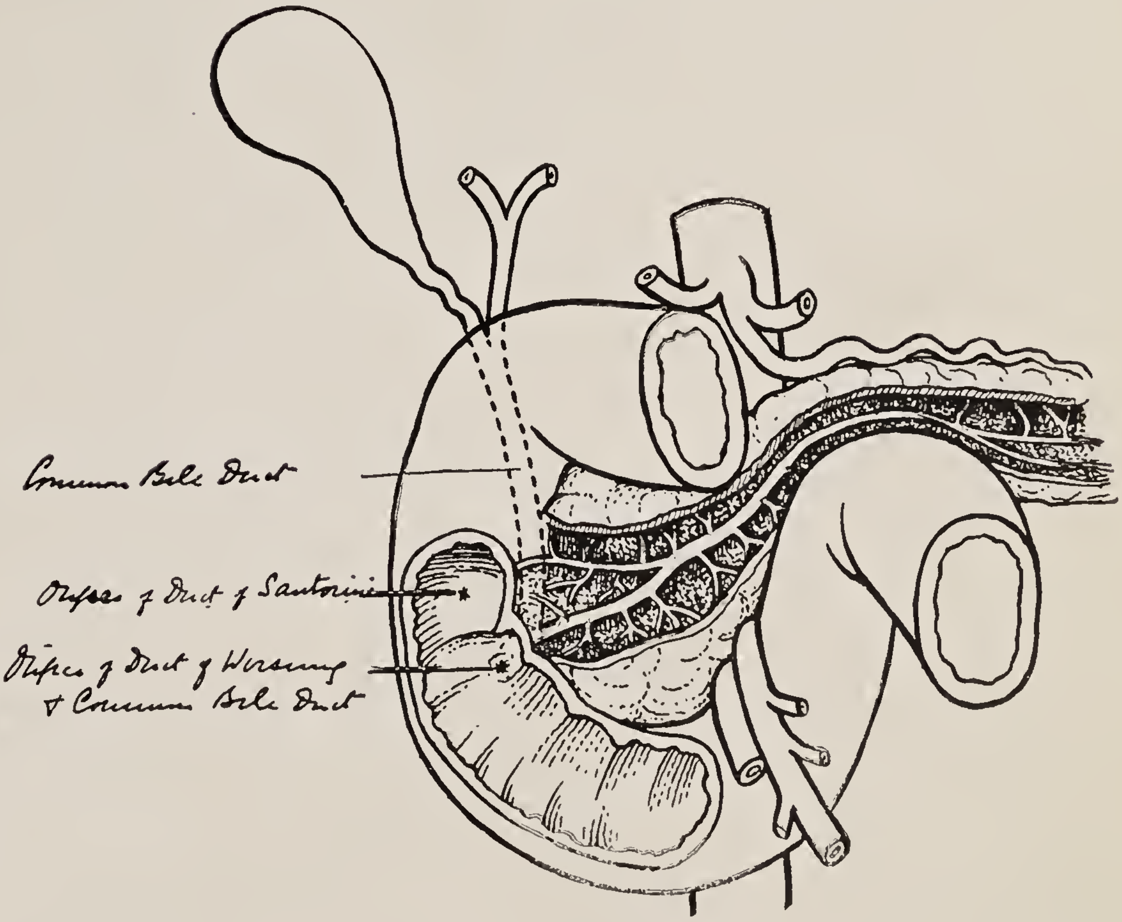


FIG. 171. AMPULLA OF VATER.



Common Bile Duct
Orifice of Duct of Santorini
Orifice of Duct of Wirsung & Common Bile Duct

FIG. 172. THE EXCRETORY DUCTS OF THE PANCREAS.

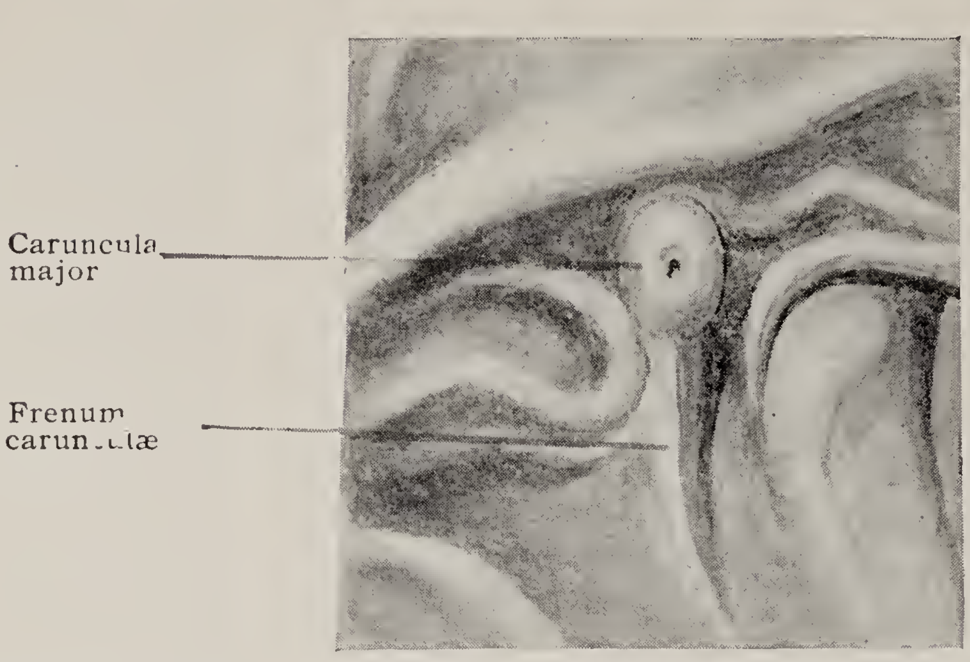


FIG. 173. OPENING OF THE AMPULLA OF VATER ON THE CARUNCULA MAJOR IN THE DUODENUM. (*After Testut.*)

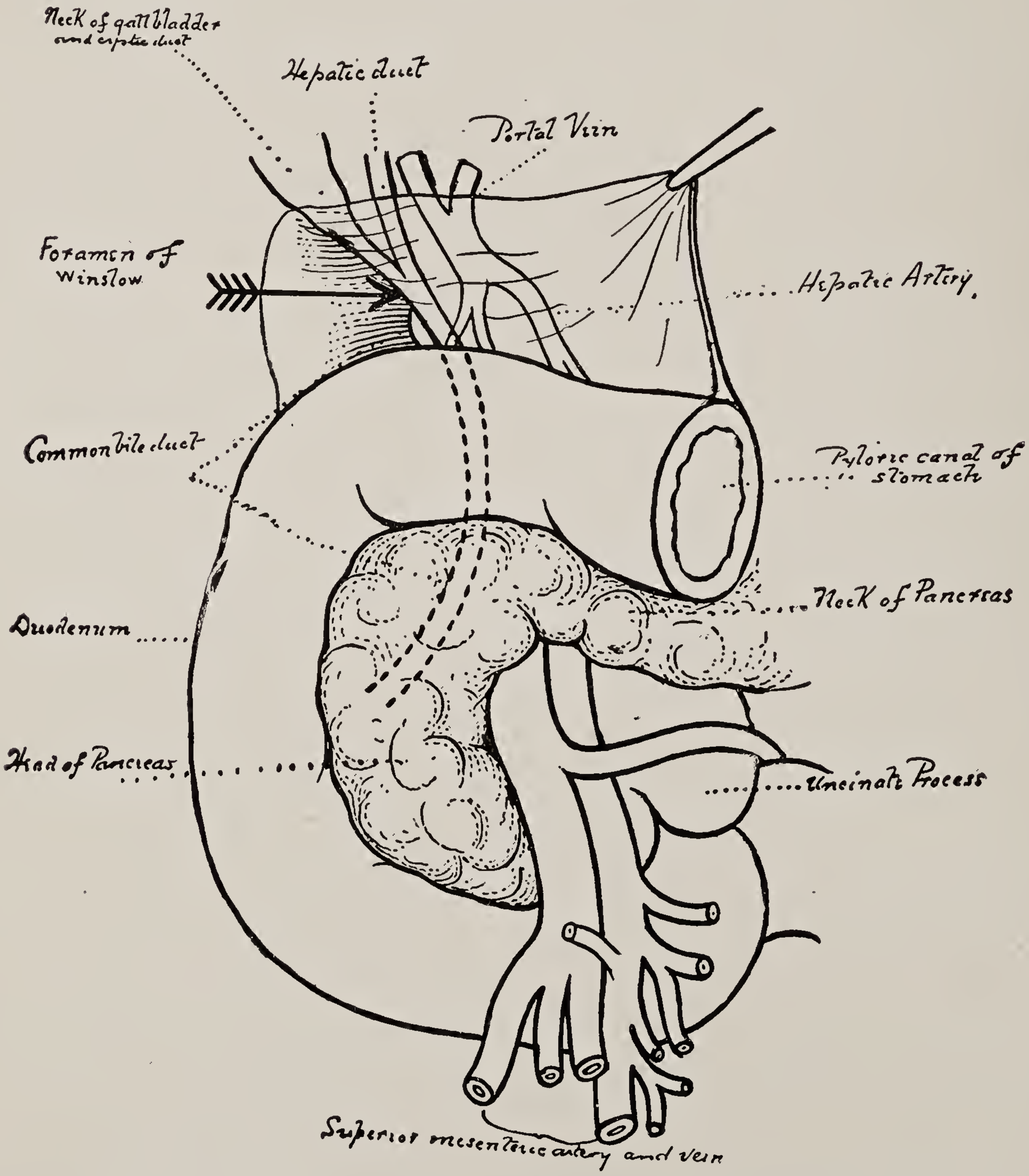


FIG. 174. HEAD OF THE PANCREAS SEEN FROM THE FRONT. (*After Testut.*)

known as the 'frenum carunculæ or plica longitudinalis.' Shortly before their termination the common bile duct and pancreatic duct usually unite to form a common channel, known as the 'ampulla or diverticulum of Vater.' This is a small oval or triangular cavity lying in the wall of the duodenum, having its apex at the duodenal orifice, and its base at the openings of the two ducts. The orifice of the common bile duct in the ampulla is above that of the pancreatic duct, and the two are separated by a small transverse fold of mucous membrane. The ampulla and the terminations of the two ducts are surrounded by a thin layer of unstriped muscle fibre, forming a sphincter (Oddi).

The accessory duct, or *duct of Santorini,* is always present, although at times it is small or partly obliterated, especially in the neighbourhood of the intestine. The opening is situated on a small papilla, 'the papilla or caruncula minor,' lying 0.75 to 1 inch above the papilla major, on which the ampulla of Vater or the main duct opens. The duct of Santorini is morphologically, and in some instances anatomically, the duct of the head of the pancreas. The relations of the common bile duct to the head of the pancreas have been described under the surgery of the biliary passages, p. 266, but it is necessary here to repeat the fact that in 62% of cases the common bile duct passes through the head of the pancreas, whereas in the remaining 38% it only lies in a deep groove on its posterior surface (see Fig. 174).

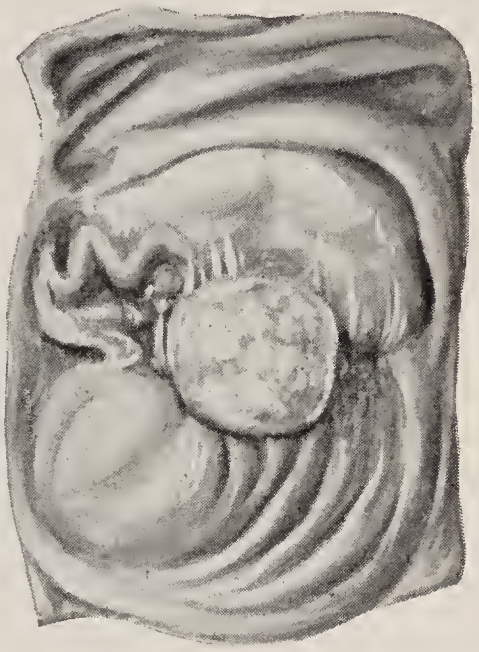


Fig. 175. Accessory Pancreas in the Wall of the Duodenum.

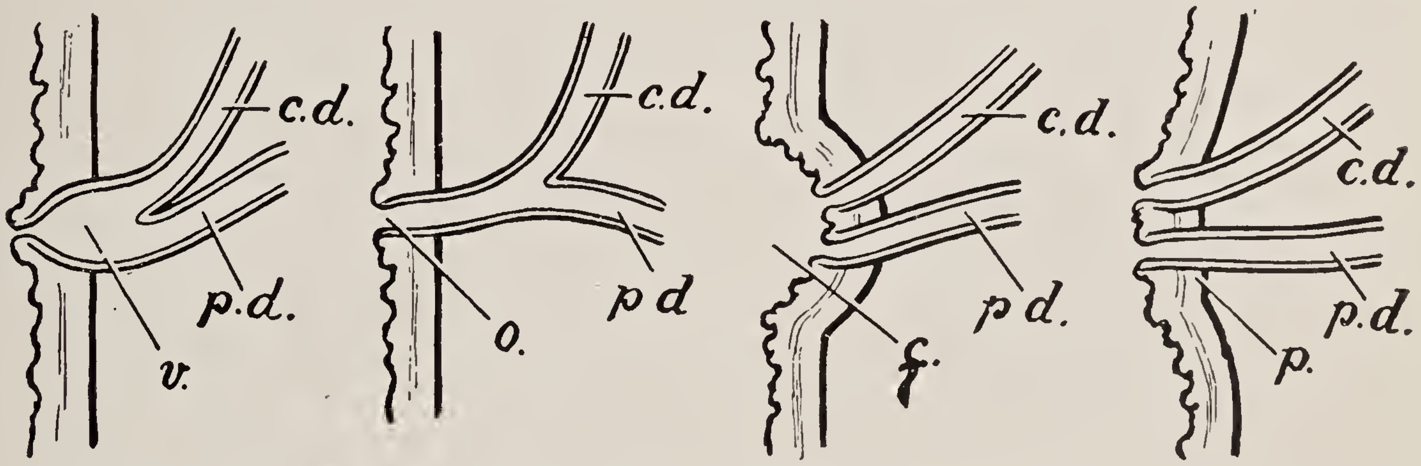


Fig. 176. Diagram to show the Four Chief Varieties in the Terminations of the Bile and Pancreatic Ducts in the Duodenum. *c.d.,* Common duct; *f.,* Fossa; *o.,* Oval orifice; *p.,* Papilla; *p.d.,* Pancreatic duct; *v.,* Ampulla of Vater.

This is important from the fact that in 62% of cases of pancreatitis jaundice to a greater or less extent will be present on account of pressure on the common bile duct.

The varying terminations of the bile and pancreatic ducts in the duodenum have also been referred to and are shown in the diagrams in Fig. 176.

EXPLORATORY OPERATIONS

As the pancreas occupies a central position in the abdomen it may be reached either from the front or from either loin according to the part of the gland that is affected. Occasionally an exploration from the front may be completed by posterior drainage, but a primary exploration from behind is rarely practised.

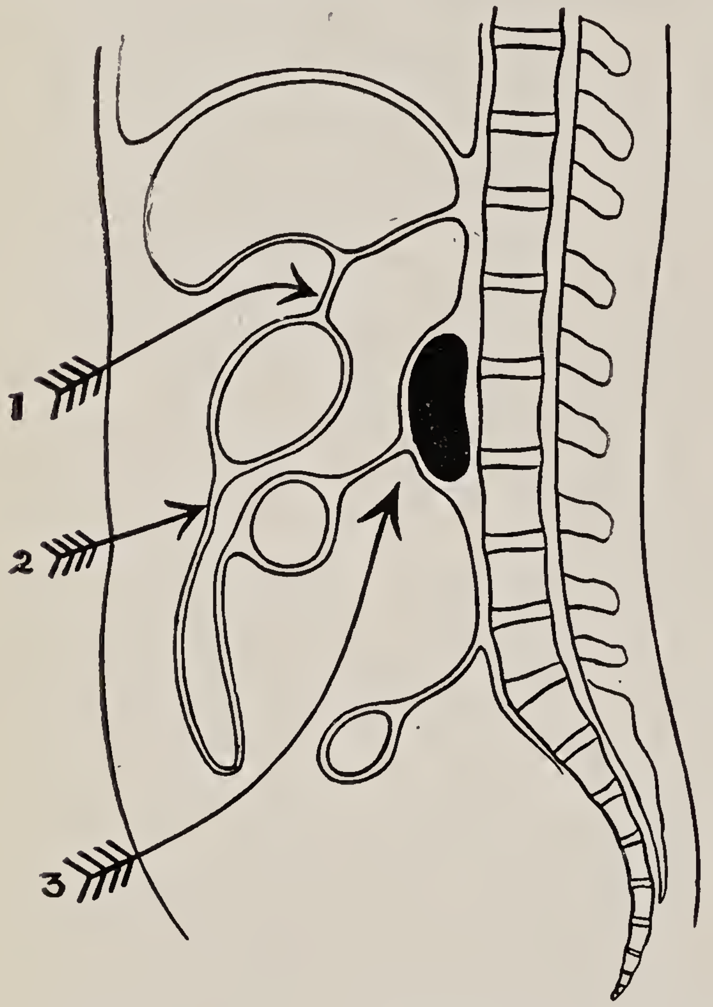


Fig. 177. The Peritoneal Folds in Relation to the Pancreas. The arrows indicate three of the approaches to the gland.

The pancreas is more readily reached from the front by using the special table shown in Fig. 116, or by arching the spine forward by placing on the table a sand-bag or an air-cushion behind the back at the liver level.

Operation. The preparation of the patient and of the area of operation, as well as the after-treatment, are the same as those described on p. 280.

An incision is made about an inch to the right of the mid-line above the umbilicus, it being extended if needful upwards to the notch between the ensiform cartilage and the right costal margin or downwards below the umbilicus. The right rectus is either split or displaced outwards after dividing the anterior rectus sheath. On incising the posterior rectus sheath and the parietal peritoneum, the pancreas will be seen above the stomach through the gastro-hepatic omentum if the patient suffers from gastroptosis, otherwise it can only be seen after displacement of viscera.

Normally the pancreas may be approached—

(*a*) Above the stomach by incising the gastro-hepatic omentum (see Fig. 177, 1).

(*b*) Below the stomach, through the upper part of the great or gastro-colic omentum (see Fig. 177, 2).

(*c*) Through the transverse mesocolon by raising the transverse colon and great omentum (see Fig. 177, 3).

(*d*) The anterior part of the head of the gland may be reached by pushing the stomach upwards and inwards and dividing the peritoneum passing over the pancreas from the duodenum.

(*e*) The posterior part of the head of the pancreas may be exposed by mobilizing the duodenum (see Fig. 178).

(*f*) The tail of the gland may be reached by raising the stomach, pressing downwards and inwards the splenic flexure of the colon, and incising the reflection of the peritoneum passing from the colon to the parietes.

In incising the peritoneal reflections, if possible a bloodless spot is selected, but if a vessel in the lesser or great omentum or in the transverse mesocolon should be divided, it is immediately ligatured.

The chief dangers encountered in operating on the pancreas are hæmorrhage and the escape of pancreatic secretion. The former may be guarded against by avoiding as far as possible any obvious blood-vessels, and in case of their division applying a ligature of catgut, which must not be drawn too tightly lest it cut through the rather fragile tissues. The latter danger may be guarded against by avoiding injury to the main ducts, or in case of injury by their careful repair; and in case of incision into the substance of the pancreas by carefully applying deep and superficial buried catgut sutures by means of a slender, round, half-curved needle and by suitable

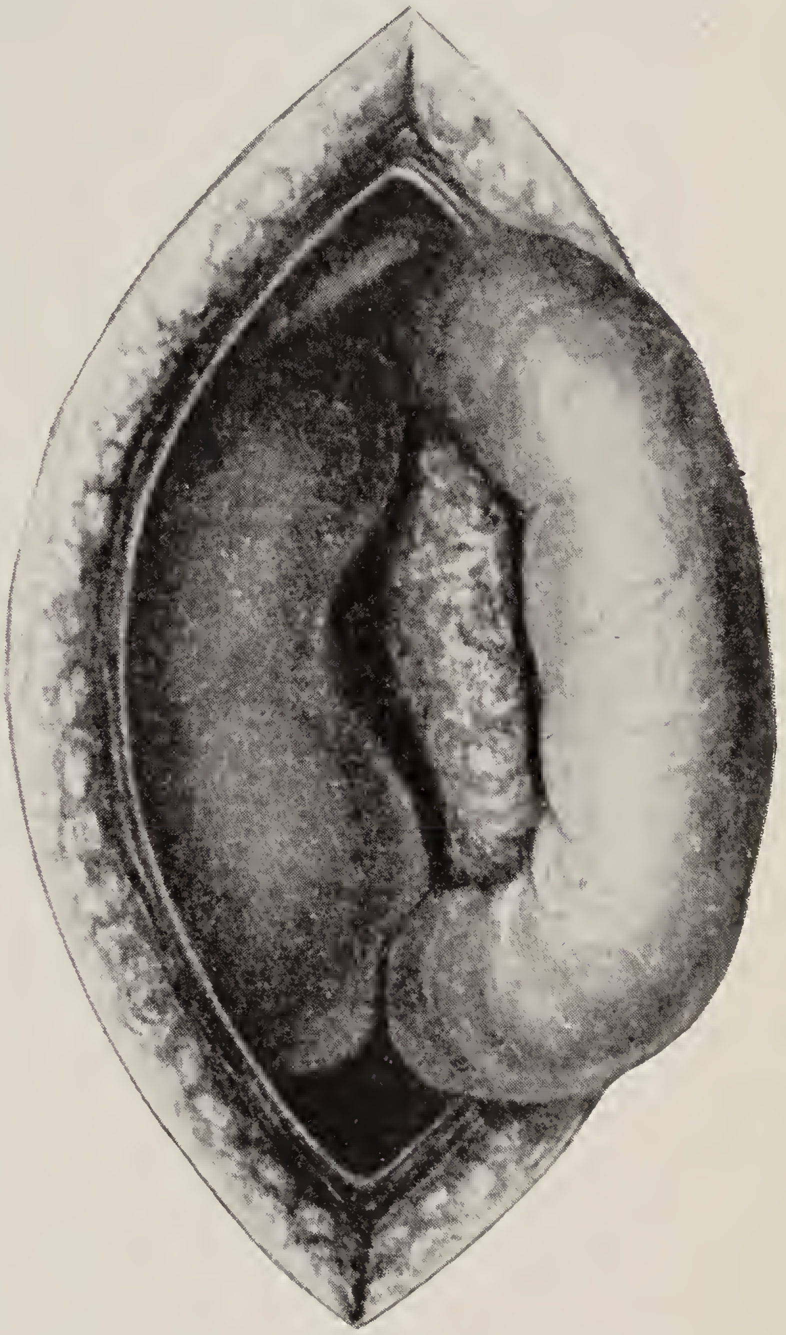


FIG. 178. MOBILIZATION OF THE DUODENUM TO EXPOSE THE POSTERIOR SURFACE OF THE PANCREAS. The surface exposed is the back of the head of the pancreas.

drainage: no dead spaces must be left and the sutures must not be drawn too tightly.

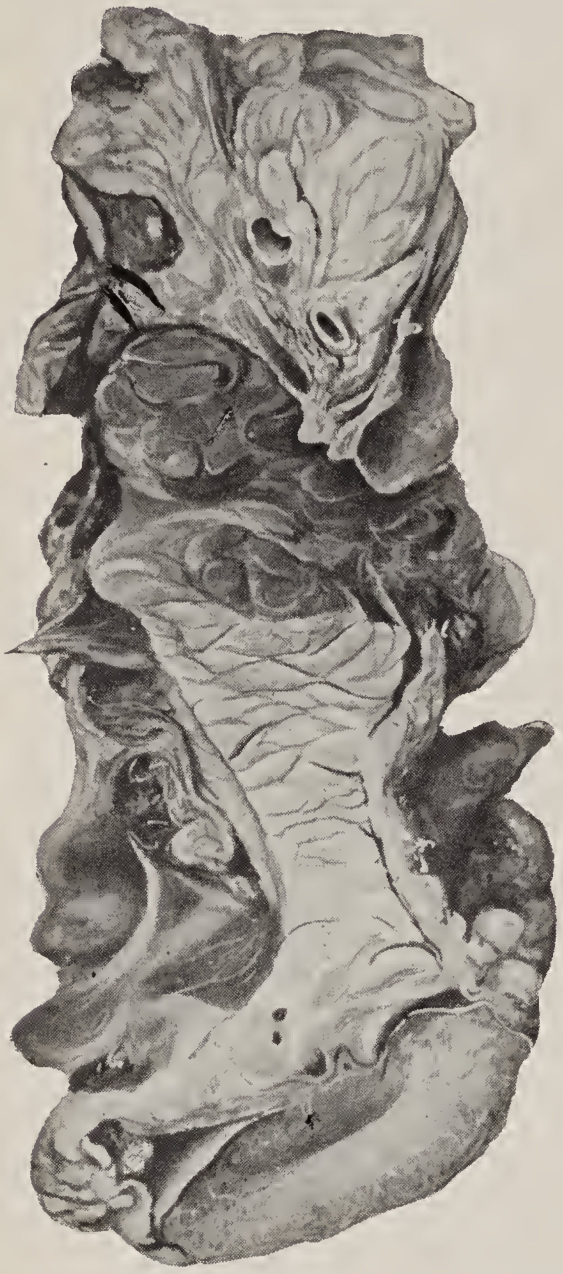


FIG. 179. LACERATION OF THE PANCREAS UNACCOMPANIED BY ANY OTHER INJURY. The accident was a crush between two vans, and on admission to hospital the patient only complained of slight pain in the epigastrium. Twenty-four hours later he became collapsed, but recovered. Subsequently he vomited, became seriously collapsed, and died three days after the receipt of the injury. At the autopsy a rupture of the pancreas dividing it into two nearly equal portions was found. There was fat necrosis in the neighbourhood, but no injury of the duodenum, liver, spleen, kidneys, or other abdominal viscera.

OPERATIONS FOR INJURY

Gunshot or stab wounds. Operation must be undertaken as speedily as possible. All bleeding points must be taken up and ligatured, rents in other organs must be sought for and repaired, and any laceration of the pancreas must be carefully cleansed and sutured by deep and superficial sutures. If needful, part of the pancreas may be resected if much lacerated, especially if near the tail of the gland; but care must be taken to avoid the main duct, the superior mesenteric artery, and the portal vein. Extensive disorganization of the gland can only be treated by gauze tampons and drainage.

Results. Of twenty-one cases of injury of the pancreas due to gunshot wounds fifteen were operated on and nine recovered; all but one not operated on died.

After injury from stab wound, direct treatment, with careful suture of the wound in the pancreas, has been very successful.

Injury without external wound. Operation. Delay will usually occur, as a diagnosis cannot always be made immediately; but as soon as signs of hæmorrhage or of inflammation manifest themselves an exploration will be advisable.

Results. In a case reported by Randall, operation six hours after the accident was followed by recovery. Garré (*Beiträge zur klin. Chir.*, June, 1905) reports a case in which a total transverse rupture of the pancreas was treated successfully by careful suture and drainage. The late Prof. von Mikulicz (*Annals of Surgery,* July, 1903) reported 45 cases of pancreatic injury, 21 penetrating, 24 subcutaneous. Of the 21 penetrating wounds, 12 were gunshot and 9 stab wounds. Five of the 12 gunshot wounds were operated on and 3 recovered. Of the 7 not operated on all died. In 7 of the 9 stab wounds the pancreas was partly prolapsed; all were operated on and recovered. Of 2 that were not prolapsed, 1 recovered. Of the 24 subcutaneous injuries, 13 not operated on died, but of the 11 operated on, 7 recovered.

OPERATION FOR ACUTE PANCREATITIS

An early exploration from the front through the middle line above the umbilicus or from behind through the left costo-vertebral angle is indicated, in order, if possible, to relieve tension, to evacuate septic material, to secure free drainage, and to arrest the hæmorrhage, which leads to disintegration and necrosis of the pancreas. Even if no pus be found no harm should accrue from such an exploration, which can be made in a few minutes. After establishing the diagnosis by abdominal section, a posterior incision in the left costo-vertebral angle will sometimes enable the diseased organ to be very freely drained for the evacuation of pus and gangrenous material without risk to the general peritoneal cavity and with little danger of retained septic matter, as the drainage will be a dependent one. If, however, the inflammatory collection of the tensely distended and inflamed gland be incised from the front, as is generally advisable, gauze packing and gauze drainage may usually be relied on to prevent general infection of the peritoneum.

If there be signs of an obstructed common bile duct, the gall-bladder should be drained, and if gall-stones be discovered they should be removed, if this can be done without seriously adding to the length of the operation or imperilling life by adding to the shock; otherwise they may be left and removed on a subsequent occasion if free drainage of the bile passages can be secured.

After-treatment. The after-treatment will be chiefly directed to combating shock and keeping up the strength until the *materies morbi,* both local and general, can be thrown off.

Results. Out of six cases of acute pancreatitis under my care, operation was performed on four, of which two recovered. Of two cases where operation was not consented to, and where medical treatment alone was carried out, death occurred in the first case on the third day and in the second case after a week's illness, attended in both with great pain and incessant vomiting.

OPERATION FOR SUBACUTE PANCREATITIS

The subacute form of pancreatitis is more amenable to treatment, as the indications are so much more definite and there is more time for careful consideration.

Operation. A median incision above the umbilicus will enable the operator to palpate the pancreas and to locate any incipient collection of pus, which, if practicable, should then be evacuated by a posterior incision in the left or right loin or in the costo-vertebral angle. If the posterior incision be thought impracticable, the collection of pus may be removed by aspiration and the cavity opened and packed with gauze, which may be brought forwards through a large rubber tube, which procedure will, in the course of from twenty-four to forty-eight hours, establish a track isolated from the general peritoneal cavity. It is important in these cases to see that the cause is removed, if that be possible—for instance, gall-stones or pancreatic calculi—so that if recovery occurs there may be no fear of relapse.

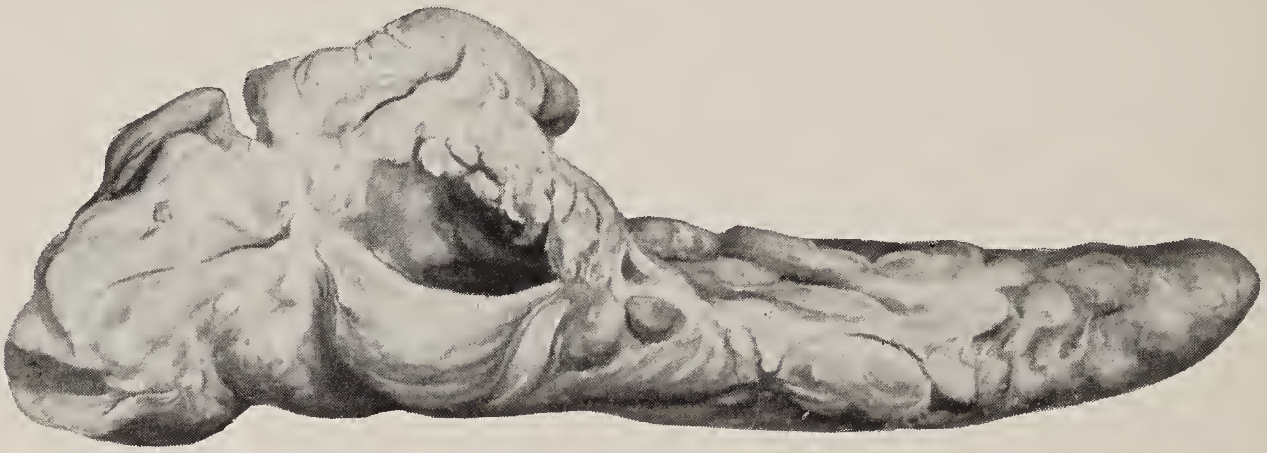


Fig. 180. Abscess of the Pancreas.

Results. Out of nine cases of abscess of the pancreas under my care, seven were operated on, with recovery from operation in six, though in one of the cases the relief was only for a few weeks and in another for a few months.

In abscess of the pancreas, which usually assumes the form of subacute pancreatitis, the suppurating process is limited by a pouring out of lymph, so that, should the patient survive the initial more acute stage, and discovery of the pus-containing cavity be made, the condition is one decidedly amenable to treatment by drainage. In one of my cases an abscess formed and was opened in the right loin of a young man, aged twenty-four years. It had been mistaken for a perirenal abscess, yet the kidney was quite healthy and the grumous pus had come from the pancreas and passed behind the peritoneum covering the second part of the duodenum. The patient recovered completely. In another case an abscess was opened in the left iliac region that had apparently started from the body of the pancreas and which had burrowed in the same way behind the peritoneum. The patient recovered from the operation, but developed trouble in the left side of the thorax and died suddenly several weeks later. In one case the abscess was subphrenic. In another, where the symptoms were rather acute and the patient was extremely ill, pus was discovered between the liver and the stomach, and although drainage was apparently complete, the patient succumbed in a few days to exhaustion due to the septic process that had been initiated before the abscess was opened. In the other two of my cases, the sequence of suppurative catarrh, abscesses of the pancreas were successfully drained through a tube in the common bile duct after removing the gall-stones which had obstructed Wirsung's duct. In one of these cases the patient, a woman aged seventy-two years, recovered completely. The other, a man aged forty years, recovered from the operation, but three months afterwards died from exhaustion, and at the necropsy the empty abscess cavity was discovered in the head of the pancreas, the rest of the gland being affected with chronic interstitial inflammation.

A search through literature reveals a considerable number of pyæmic abscesses of the pancreas, but those resulting from subacute pancreatitis have been rarely recorded. Besides seven operations for abscess of the pancreas with two deaths above referred to, there have been seven others recorded with three deaths. Thus, of fourteen cases five died, giving a mortality of 35.6%.

OPERATION FOR PANCREATIC LITHIASIS (PANCREO-LITHOTOMY)

Pancreatic calculi are so rare that Oser, in 1903, could only find seventy recorded cases. The calcareous composition of pancreatic calculi renders them opaque to the X-rays and affords a means of differential diagnosis between them and gall-stones. This fact I had the honour of first pointing out in 1904. The accompanying X-ray photograph shows the comparison (see Fig. 182).

Operation. An incision 3 to 4 inches long, 1 inch to the right of the middle line, will be found the most convenient, as the fibres of the right rectus can be split and the incision lengthened upwards and downwards without unnecessarily weakening the abdominal wall. A sand-bag under the lumbar spine will bring the gland several inches nearer the surface.

If the opening of the duct of Wirsung has to be explored, the second part of the duodenum may be incised and the papilla common to the bile duct and pancreatic duct laid open, when the edges of the opened diverticulum of Vater can be seized with small catch-forceps and drawn to the surface; a probe or fine forceps can then be readily passed into Wirsung's duct and any concretion removed.

If the calculi be more deeply placed in the ducts, the pancreas may be exposed either through the gastro-hepatic omentum by drawing the stomach downwards, or by lifting the stomach it may be reached through an opening in the omentum; or by raising the colon it may be approached by a slit in the transverse mesocolon. By peeling the duodenum from the parietes the back of the pancreas may be readily reached. The calculi may be then cut down on and extracted by a scoop or forceps. Any bleeding must be arrested by ligatures. The duct can be sutured and the incision in the gland must be brought together by buried sutures, the peritoneal covering being coapted by a continuous suture. If leakage be feared, a gauze drain may be applied; but the position may be difficult for this, and if it has to be done the gauze must be surrounded by a rubber drainage tube and brought through it to the surface. In my case of pancreo-lithotomy referred to below, the closure of the gland was so secure as not to require guaze packing, and the result justified its not being used. When the duodenum has been opened it must be closed in the usual way by a muco-muscular and serous suture, the latter being of fine celluloid thread. The incised papilla need not be sutured.

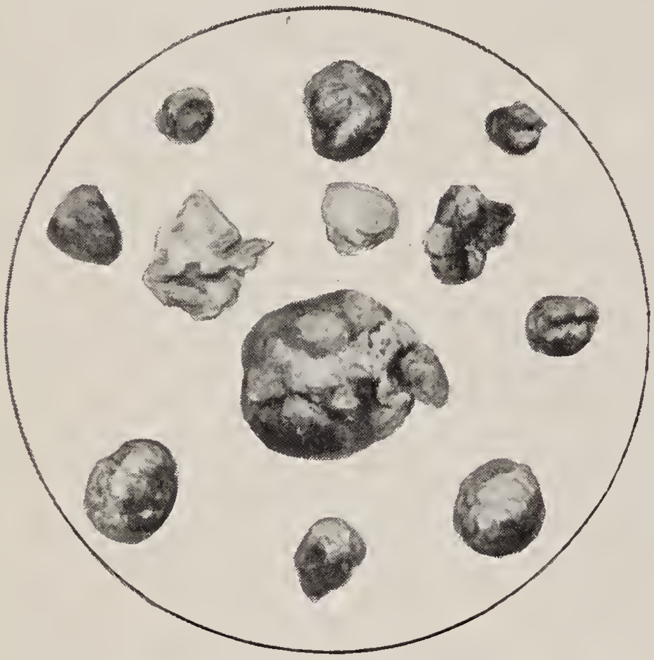


Fig. 181. Drawing from a simple Photograph of Gall-stones and Pancreatic Calculi removed from one Patient by the Author.

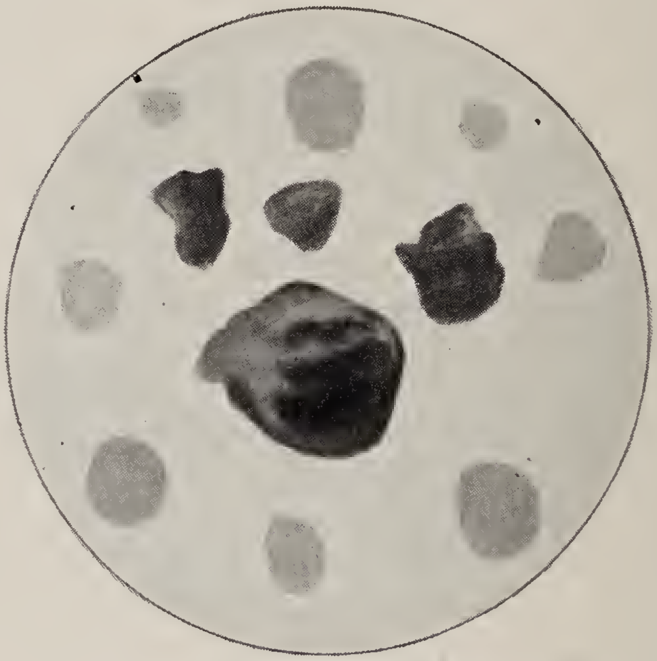


Fig. 182. Skiagram of the previous Photograph. Showing that the pancreatic calculi are opaque to the X-rays.

If a calculus be felt in the head of the gland, but not in the duct of

Wirsung, it may be reached by incising the peritoneum over the duodenum and separating it gently from the head of the pancreas, or if more deeply placed near the back of the gland the reflection of peritoneum from the duodenum to the abdominal wall may be incised and the duodenum may then be displaced inwards, when the back of the pancreas will be exposed, and, if thought advisable, it may be incised and treated as in the incision from the front.

Results. In a case which came under my care on February 13, 1903, four calculi were removed from a woman aged fifty-seven, one from the duct of Santorini, or one of its branches, by direct incision into the pancreas close to the common duct, the opening being afterwards closed by deep and by peritoneal sutures; the second and third stones were reached through an incision in the duodenum by laying open the papilla, when by means of fine forceps a calculus was removed out of Wirsung's duct, along which a probe was afterwards passed for 2 inches, and a fourth concretion was removed by direct pancreatotomy from the middle of the duct of Wirsung, the stone being reached by incising the gastro-hepatic omentum, drawing the stomach downwards, incising the pancreas freely, and opening the duct directly on to the stone, which was of the size of a small bean. The duct was then closed with catgut, the wound in the body of the pancreas being sutured so as to leave no dead space and the peritoneal wounds being closed without direct drainage. The right kidney pouch was then drained, as some infected bile had escaped. Recovery was ultimately complete. This is, apparently, the first case in which either the duct of Wirsung or the duct of Santorini has been deliberately opened and, after the removal of a calculus, closed by a suture.

A very exhaustive search through English and foreign literature has only resulted in the discovery of five operations for pancreatic calculi. Mr. A. Pearce Gould's case, operated on March 3, 1896, died on the twelfth day from exhaustion. In Dr. Dalziel's case a stone of the size of a very large pea was removed from the pancreatic duct through an incision in the duodenum, the opening in the duct being stitched to the wound in the posterior wall of the duodenum. As the bile duct was clear there was no jaundice. A good recovery followed. In Mr. B. G. A. Moynihan's case a pancreatic stone was removed from the ampulla of Vater through an incision in the duodenum, and the patient recovered. In Dr. L. W. Allen's case two calculi were removed from a cyst between the lesser curvature of the stomach and the liver. The patient died on the fifth day after operation.

OPERATION FOR PANCREATIC CYSTS

Cysts of the pancreas may be divided into false and true. The false or pseudo-cysts may be due to a distension of the lesser peritoneal sac, or to a localized collection of fluid in the neighbourhood of the pancreas.

True cysts may be due to retention from various causes, to parasitic disease—*e.g.* hydatids—to new growths, as in proliferation cysts, and to hæmorrhage. A few cases of congenital cystic disease have been recorded.

The physical signs of cysts of the pancreas are by no means constant. A consideration of the peritoneal reflections from the pancreas on to the viscera, and how they influence the ultimate position and relations of the pancreatic cysts, will render the reason for this clear.

The explanation of these variations, which may, and often do, lead to difficulties in diagnosis, is an anatomical one, and depends on the site of the origin of the cyst, which in making its way to the surface proceeds in the line of least resistance, and is thus influenced by the reflections of the peritoneum and the arrangement of the viscera overlying the gland.

Fig. 185 shows the position of a number of cysts of the pancreas upon which I have personally operated, and illustrates the great variety in the clinical characters.

Aspiration and other forms of tapping are inadequate and ineffectual methods, which are attended with more danger than is the operation of incision and drainage. They are, therefore, not to be recommended, even for diagnostic purposes. Occasionally complete extirpation of the cyst may be performed, as in a case that came under my care, where the tumour returned a few months after it had been apparently successfully treated by drainage; but the greater difficulty in performing excision, its impracticability in certain cases, and the greater mortality attending it, as compared with the operation of incision and drainage, make it quite clear that drainage should always have a fair trial unless the circumstances prove to be very exceptional, as, for instance, in the case of a cyst of the tail of the pancreas, or in the case of a pedunculated cyst.

As to the situation for drainage, that will depend on circumstances. The tumour will usually be attacked most readily from the front at a point where it very nearly reaches the surface. Occasionally, however, it may be drained from the loin.

Fistula does not, as a rule, follow the drainage of pancreatic cysts, but in some cases a small fistula may persist and may go on for years without hurt to the patient and with very little discomfort.

The following is a description of the operation usually performed: An incision is made through the parietes opposite the most prominent part of the cyst. When the peritoneum is opened, the finger can be employed to ascertain the relations of the cyst and its attachments. If the stomach be in front of the cyst, it will be better to displace that viscus upwards and to make a slit through the great omentum in order to expose the cyst-wall; if the colon be in front, it may be displaced downwards. But no rule can be formulated, as the cyst must be reached in the most convenient way, and that can be ascertained only when the abdomen is open. By means of an aspirator the fluid is then drawn off, and an opening made in the cyst sufficiently large to allow of a drainage tube being inserted. The tube may then be fixed to the margin of the incision in the cyst by a single catgut suture, and if the opening into the cyst be surrounded by a purse-string suture, which can be tightened around the tube, all fear of leakage from the cyst into the peritoneal cavity is avoided. Any vessels coursing over the cyst must be avoided, but should an artery or vein be pricked, it must be caught between pressure-forceps and ligatured.

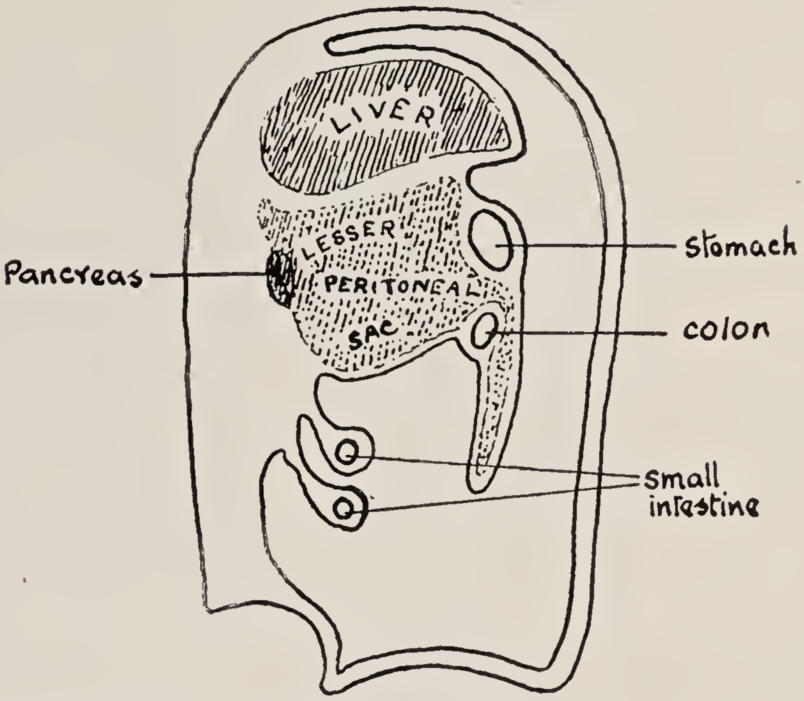


Fig. 183. Pseudo-cyst of the Pancreas due to Effusion in the Lesser Sac of the Peritoneum.

The edge of the cyst may then be fixed to the aponeurosis by three or four sutures, but it is better not to attach it to the skin. The abdomen is then closed, and if the tube be sufficiently long it will readily drain into a bottle containing some antiseptic fluid. If, on exploration, the cyst be found to have a narrow attachment to the pancreas and the adhesions are not too extensive, it may possibly be shelled out, or the pedicle may be ligatured, but this is rarely feasible.

Some surgeons have suggested the desirability of fixing the cyst to the surface and only opening it after a few days, when adhesions have been formed, but this operation *à deux temps* seems to be quite unnecessary.

Results. In the cases that have come under my personal observation, one cyst was enucleated, recovery following; drainage was carried out in ten cases of true cyst, recovery following in nine; whereas of two pseudo-cysts, one due to traumatic hæmorrhagic pancreatitis and the other to necrotic pancreatitis, one recovered.

Of the 160 cases of operation recorded by others, there were 140 recoveries; in 4 cases the ultimate issue was doubtful; in 8 out of the 140 reported recoveries after operation the patients died subsequently —1 from diabetes four months later, 1 from hæmorrhage one and a half years later, 1 from concomitant peritonitis seven weeks later, 1 from a zymotic fever a few weeks later, and 4 from causes not stated a few weeks later. Death is recorded as the result of operation in 20 cases. In 5 of these the cause of death and the time after operation are not given. One patient died in collapse, 1 died before operation could be completed (the next day), 1 died from 'ileus,' 1 died eighteen days after operation (cause not stated), 2 died from shock, 1 died from

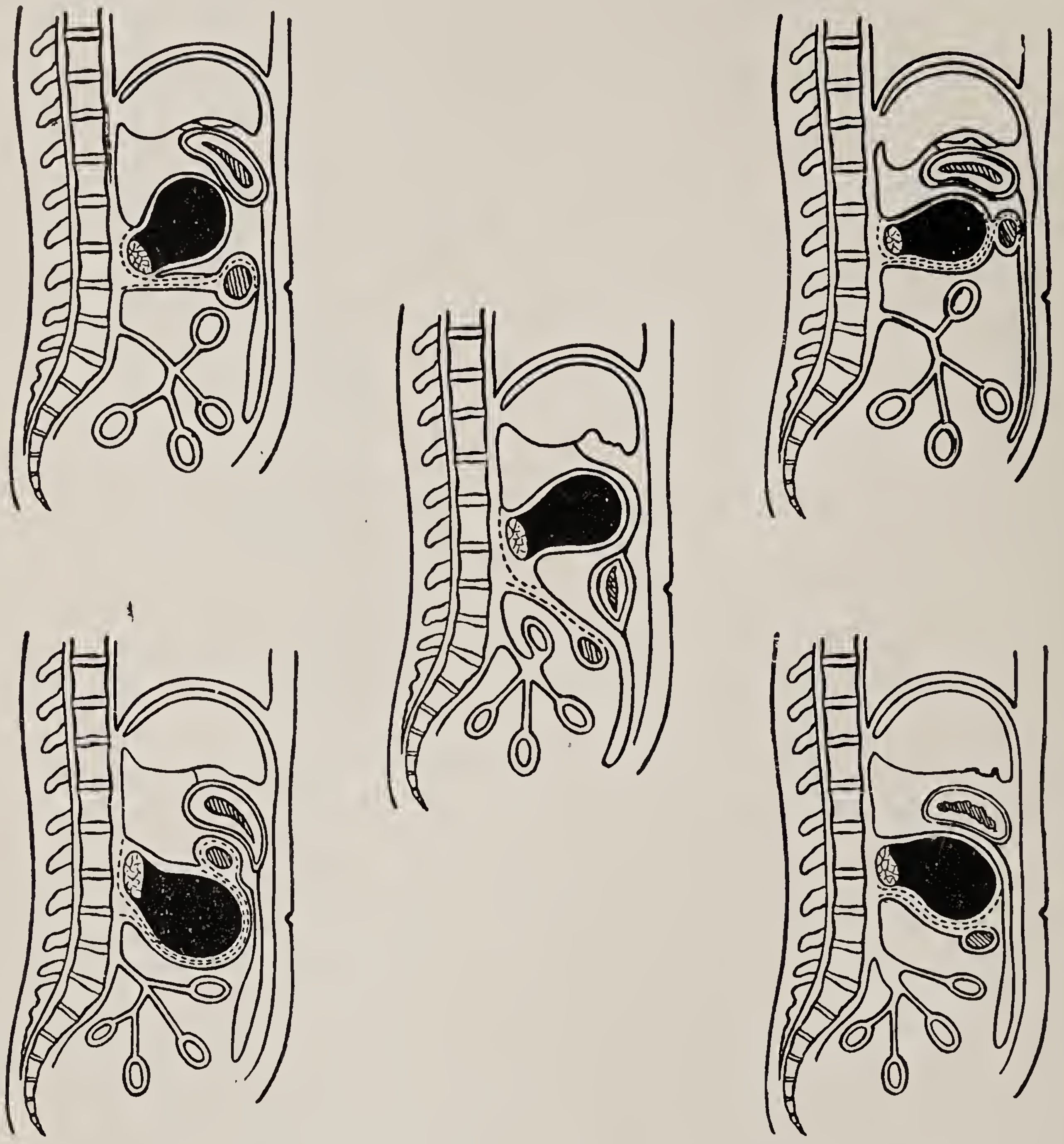


Fig. 184. Cysts of the Pancreas advancing towards the Surface by Different Routes.

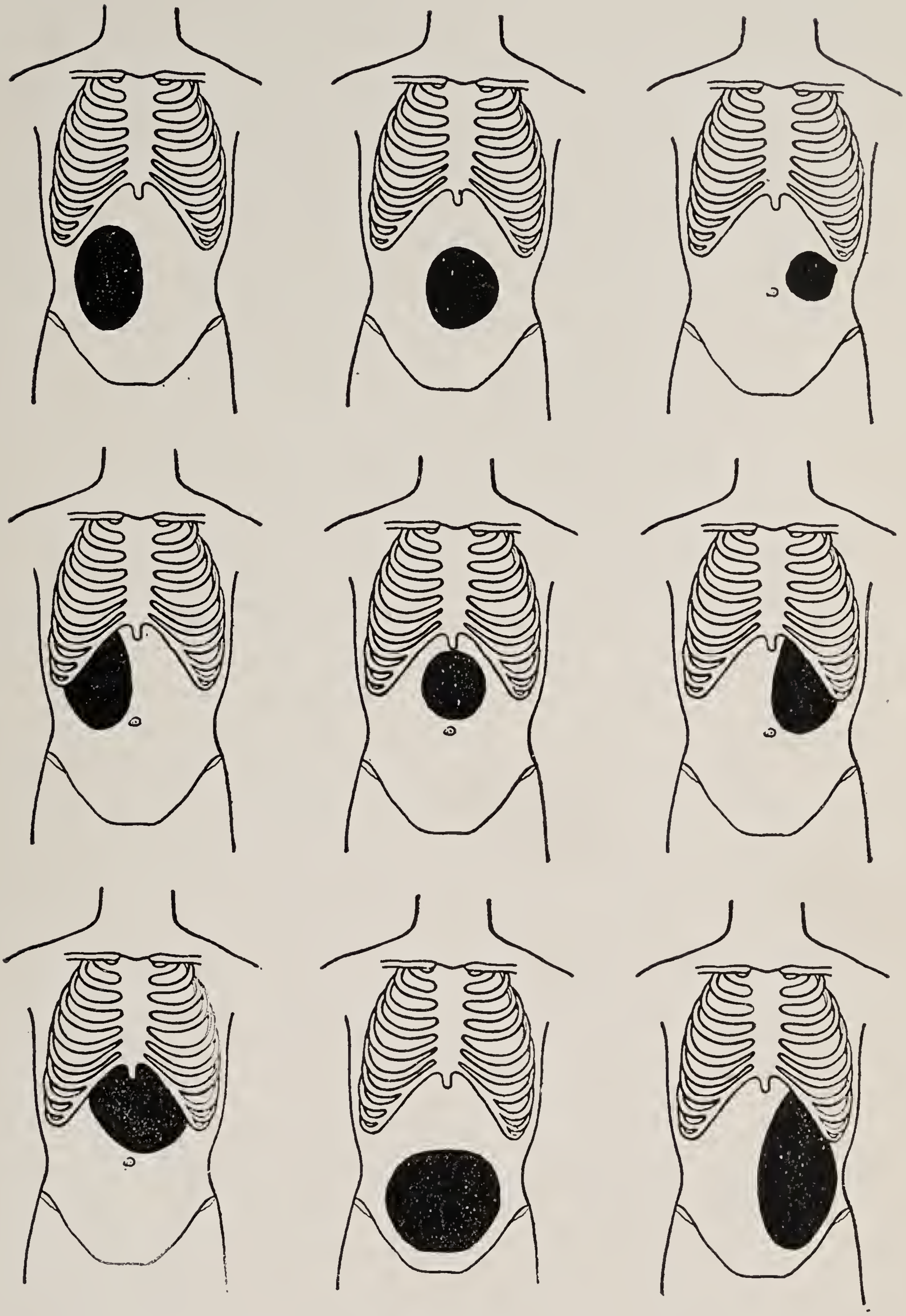


Fig. 185. Diagram of Various Pancreatic Cysts that have come under the Observation of the Author and which illustrate the Simulation of other Tumours.

gangrene of the pancreas, and 8 died from peritonitis. Of these latter, 1 died at an interval not stated, 1 after ninety-six hours, 1 after six days, 1 after an exploratory incision, 2 after two days, 1 on the eighth day, and 1 on the second day. In 138 cases incision and drainage were performed, with 16 deaths, equal to a mortality of 11.6%. In 15 excision was performed, with 3 deaths, equal to a mortality of 20%. In 7 partial excision was done, with 1 death, equal to a mortality of 14.3%.

Although larger numbers have been reported by others, the above figures are as nearly correct as possible, for on verifying the records sometimes the same case had been reported twice, in others wrong dates had been given, and in a few the details were so meagre that the nature of the operation was not given. The evidence is clearly in favour of drainage, but the mortality should certainly be reduced by one-half.

Hydatid cysts must be treated by drainage and evacuation of the daughter cysts, and on no account must excision of the cyst-wall be attempted, though in some cases it may be possible to completely evacuate the endocyst and thus to expedite recovery.

OPERATION FOR GROWTH IN THE PANCREAS

Tumours of the pancreas are usually of a malignant nature.

Operation. Surgical treatment is not very hopeful, and has usually been undertaken under the idea that the cause of the jaundice might be a removable one, or that drainage of the bile ducts might afford relief, but if the disease has involved the head of the pancreas it is hopeless, however treated.

Operation may be radical or palliative. Ruggi, of Bologna, removed through the loin a cancer of the pancreas weighing 23 ounces. It was probably growing from the tail of the gland. Complete recovery followed and the patient was well for three months, after which secondary disease developed and the patient died at the end of six months. Professor Ruggi himself has kindly furnished these details. Billroth, in 1894, removed the whole pancreas and the patient recovered. Cades's was the third successful case, in 1895, a tumour of the tail of the pancreas of the size of a child's head being removed. Terrier, in 1892, removed a tumour weighing 5 pounds, but lost his patient. Franke, in 1901, removed the whole of the pancreas with recovery of the patient. Of sixteen operations for removal of solid tumours of the pancreas, eight recovered; which, considering the difficulty of the operation and the depth of the organ to be operated on, is better than one would have expected. Successful pancreatectomies, it will be seen, are exceptional and are feasible only where the growth is not involving the head of the gland; they, however, clearly demonstrate that a tumour of the body or of the tail of the pancreas may be removed with a chance of recovery, and should the disease be primary, and no secondary growth or glandular involvement have occurred, considerable prolongation of life is quite possible.

Desjardins (*Rev. de Chirurgie,* June 10, 1907) advocates the more frequent performance of pancreatectomy, and has proposed an operation which involves complete excision of the duodenum, partial excision of the pancreas, cholecystenterostomy, and gastro-enterostomy. The illustrations are admirable, and if the operation of complete pancreatectomy should ever be considered justifiable, this method proposed by Desjardins would seem to commend itself as being mechanically possible.

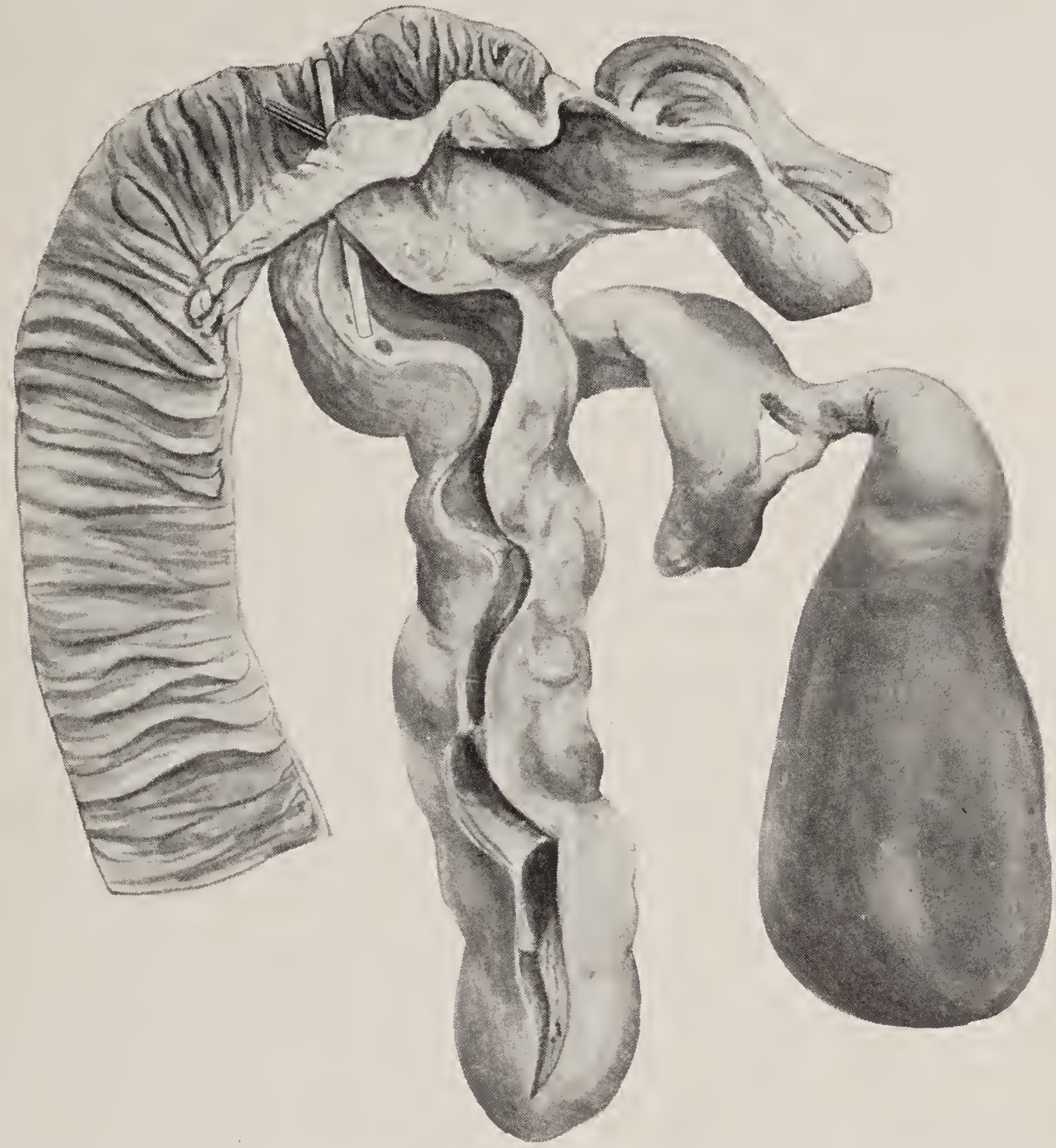


FIG. 186. CANCER OF THE HEAD OF THE PANCREAS. Drawing of Specimen No. 1414, St. Thomas's Museum. Showing dilatation of the bile ducts, gall-bladder, and Wirsung's duct.

SECTION V

OPERATIONS UPON THE CENTRAL NERVOUS SYSTEM

PART I

OPERATIONS UPON THE SKULL AND BRAIN

BY

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PART II

SURGERY OF THE HYPOPHYSIS

BY

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CHAPTER I

CRANIO-CEREBRAL TOPOGRAPHY

The surgeon who is called upon to carry out operations on the skull and brain must possess an accurate knowledge of the anatomy of the parts involved. Added to this, he must have at his command some simple method of depicting on the surface of the skull the more important structures.

The more complicated systems of cranio-cerebral topography are of little practical value to the surgeon. Simplicity is essential, and the following outline will be found to furnish an adequate practical guide.

Firstly, the skull can be divided into two lateral halves by the surface-marking of the superior longitudinal venous sinus.

The superior longitudinal sinus. This sinus originates at the crista galli and, passing backwards along the attached margin of the falx cerebri, terminates at the internal occipital protuberance. It may be represented by a line drawn from the base of the nose (the nasion), over the vertex of the skull, to the external occipital protuberance (the inion)—this line corresponding in its course to the occasionally persistent metopic suture between the two halves of the frontal bone, to the sagittal suture between the parietal bones, and to the middle line of the upper or tabular portion of the occipital bone.

Secondly, each lateral half of the skull can be subdivided into supra- and infratentorial regions by a line which marks the external attachment of the tentorium cerebelli; in other words, by the line of the lateral sinus.

The lateral sinus. This sinus is represented by a line presenting a slight upward convexity, which is drawn from the external occipital protuberance to the upper and posterior part of the mastoid process of the temporal bone.

The infratentorial region. The cerebellum lies wholly beneath the tentorium cerebelli, and it is obvious that, in operations carried out over this portion of the brain, the surgeon is limited in his field of exposure, above by the line of the lateral sinus, and on either side by the posterior border of the mastoid process. The division between the halves of the cerebellum may be represented by a line drawn vertically

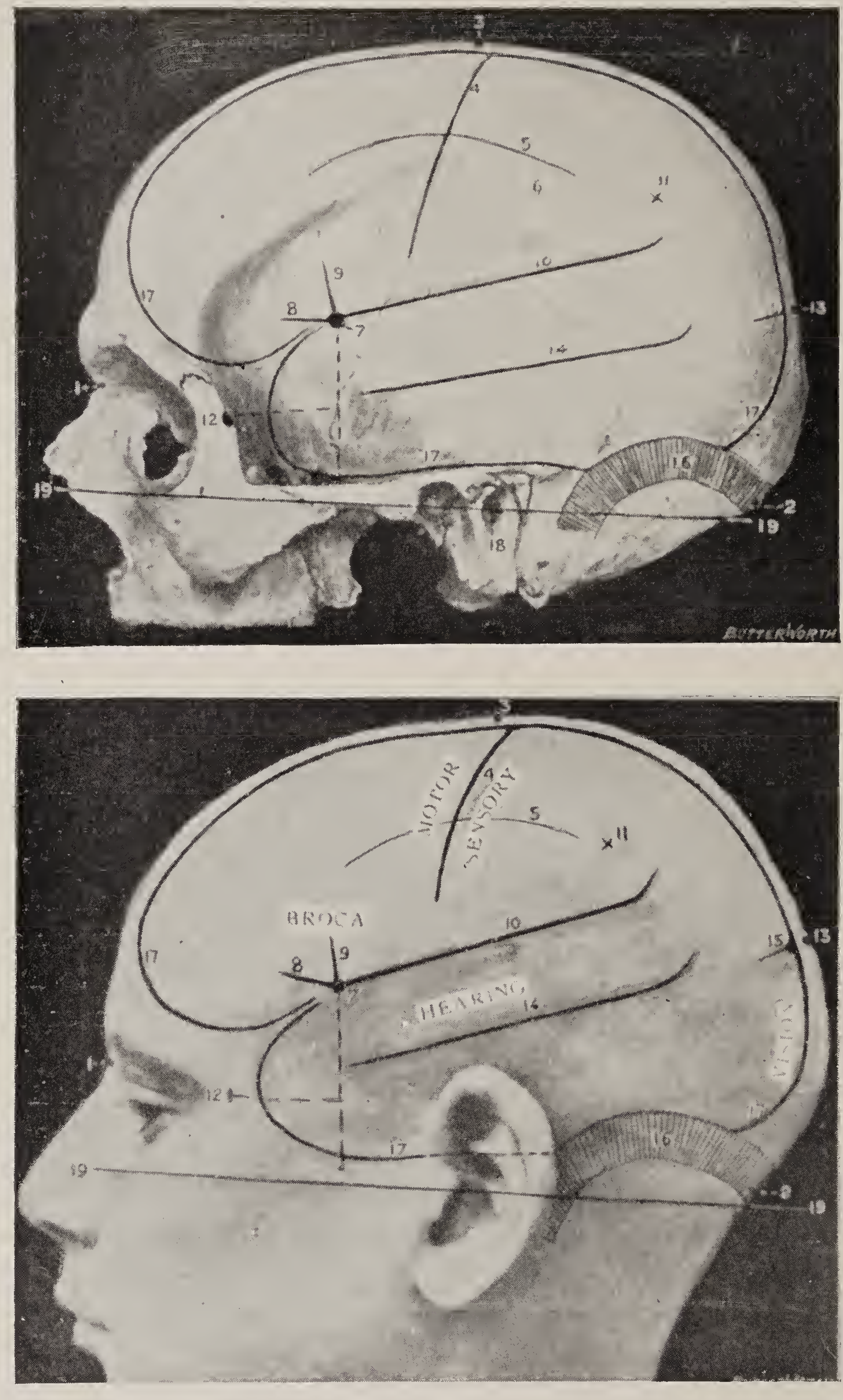

FIG. 187. CRANIO-CEREBRAL TOPOGRAPHY. 1, The nasion; 2, The inion; 3, The mid-point between nasion and inion; 4, The Rolandic fissure; 5, The superior temporal crest; 6, The inferior temporal crest; 7, The Sylvian point; 8, The anterior horizontal limb of the Sylvian fissure; 9, The vertical limb of the Sylvian fissure; 10, The posterior horizontal limb of the Sylvian fissure; 11, The parietal prominence; 12, The malar tubercle; 13, The lambda; 14, The first temporo-sphenoidal sulcus; 15, The external parieto-occipital sulcus; 16, The lateral sinus; 17, 17, 17, The level of the base of the cerebrum; 18, The external auditory meatus; 19, 19, Reid's base line. (*Reproduced, by the permission of Mr. H. K. Lewis, from the author's work on 'Landmarks and Surface-markings.'*)

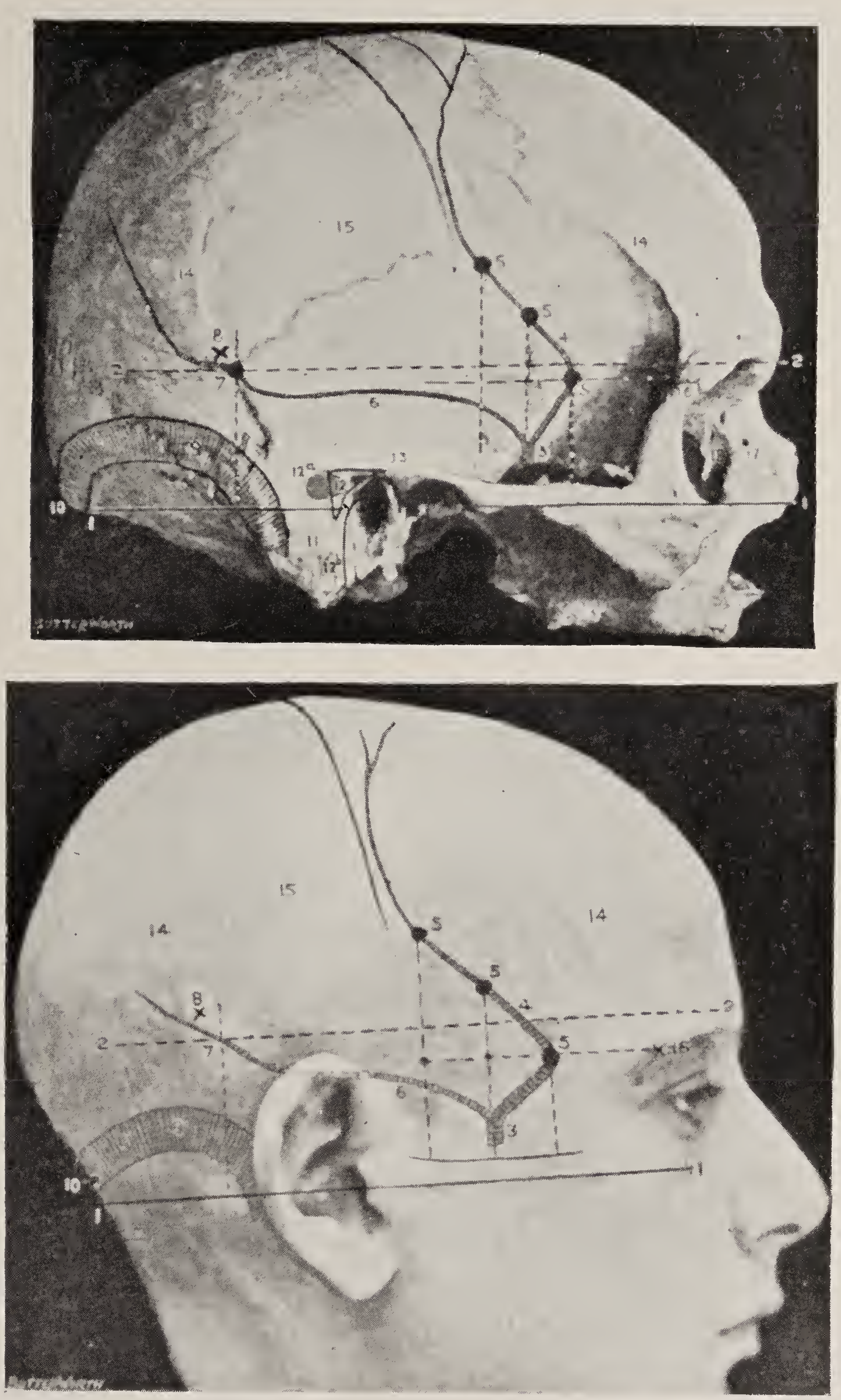

Fig. 188. Cranio-cerebral Topography. 1, 1, Reid's base line; 2, 2, A line parallel to the above at the level of the supra-orbital margin; 3, The middle meningeal artery; 4, The anterior branch; 5, 5, 5, The three sites for trephining; 6, The posterior branch; 7, The site for trephining; 8, The point for trephining to reach the descending horn of the lateral ventricle; 9, The lateral sinus; 10, The inion; 11, The mastoid process; 12, Macewen's suprameatal triangle; 12*a*, The mastoid antrum; 12*b*, The facial nerve; 13, The suprameatal and supramastoid crests; 14, 14, The temporal crest; 15, The temporal fossa; 16, The external angular frontal process; 17, The tendo-oculi attachment; 18, The lachrymal groove. (*Reproduced, by the permission of Mr. H. K. Lewis, from the author's work on 'Landmarks and Surface-markings.'*)

downwards from the external occipital protuberance to the nuchal region. This line also represents the surface-marking of the occipital sinus and falx cerebelli.

The supratentorial region. Brief allusion must be made to certain landmarks that aid in the representation of structures situated in this region:—

(*a*) *The external angular frontal process.* The suture between the external angular frontal process and the corresponding process of the malar bone lies immediately above the central point of the outer border of the orbital cavity.

(*b*) *The malar tubercle.* A slight prominence on the posterior border of the frontal process of the malar bone, about ¼ inch below the external angular frontal process.

(*c*) *The temporal crest.* A prominent ridge that is directed upwards and backwards from the external angular frontal process. The crest cuts across the lower portion of the parietal bone, passing below the parietal prominence, and curves downwards towards the upper and posterior portion of the mastoid process. It terminates by becoming continuous with the upper root of the zygomatic process. The crest consists of two parts, the upper and lower temporal crests. To the upper is attached the temporal fascia, to the lower the temporal muscle. The lower crest is almost invariably the more prominent.

(*d*) *The parietal prominence.* The central and most prominent part of the parietal bone. It indicates the point at which ossification commenced, and lies about ¾ inch above the termination of the posterior horizontal limb of the fissure of Sylvius.

(*e*) *The zygoma.* When traced in the backward direction the zygoma is found to divide immediately in front of the ear into three roots, of which the anterior, merging into the eminentia articularis, and the middle, aiding in the formation of the post-glenoid process, are of no practical utility in surface-marking. The upper or posterior root sweeps backwards above the external auditory meatus to become continuous with the suprameatal and supramastoid crests, the former of which forms the upper boundary of *Macewen's suprameatal triangle,* a triangular depression at the upper and posterior border of the external auditory meatus. This triangle may be taken as representing the opening of the mastoid antrum into the middle ear.

These landmarks having been determined, the following structures may be mapped out on the surface of the skull.

The middle meningeal artery. This artery is given off from the internal maxillary; after a short extra-cranial course it enters the skull through the foramen spinosum, and soon divides into two main terminal branches. The site of division corresponds to a point situated just above the centre of the zygoma.

The *anterior branch* passes at first in a forward and upward direction towards the anterior inferior angle of the parietal bone, and then turns upwards and backwards towards the vertex of the skull. The main ‘danger zone’ in the course of this vessel may be mapped out by taking points which lie respectively 1, 1½, and 2 inches behind the external angular frontal process and an equal distance above the upper border of the zygoma. A line uniting these three points represents that part of the anterior division of the middle meningeal artery which is most liable to injury and which therefore most frequently requires exposure.

The uppermost point may, however, be regarded as the ‘site of election’ for exposure of the artery, as, in trephining over either of the two lower points, difficulty may be experienced in the removal of the disk of bone, since the posterior border of the great wing of the sphenoid tails off on to the anterior inferior angle of the parietal bone in such a manner that to effect a clean removal of the disk of bone is often impossible. Another disadvantage to trephining low down lies in the fact that in about 30 to 40% of cases the artery occupies, in that situation, a canal in the bone.

The *posterior branch* passes almost horizontally backwards, parallel to the zygoma and supramastoid crest, towards the posterior inferior angle of the parietal bone. The vessel can readily be exposed by trephining over the point at which a line drawn backwards from the upper border of the orbit, parallel to Reid's base-line,[1] cuts another line directed vertically upwards from the posterior border of the mastoid process.

Both branches of the middle meningeal artery possess important relations to the cortex cerebri, the anterior branch passing upwards in relation to the precentral or motor area, traversing, from below upwards, the motor speech area (on the left side of the head), the centres for the movements of the face, upper extremity, trunk, and lower extremity. The posterior branch, on the other hand, passes backwards in relation to the temporo-sphenoidal lobe, one of the so-called ‘silent areas’ of the brain. Throughout their course the middle meningeal vessels lie between the dura mater and the bone.

The lower limit of the cerebrum. The lower limit of the cerebrum can be mapped out in the following manner: From a point situated about ½ inch above the nasion a line is drawn outwards which follows the curve of the upper border of the orbit as far as the external angular frontal process, thence curving upwards and backwards to the Sylvian point (see below). The temporo-sphenoidal lobe sweeps forwards to the posterior border of the malar bone, and its lower limit lies practically flush with the upper margin of the zygoma. At and behind the ear the lower limit of the cerebrum corresponds to the supra-meatal and supramastoid crests, subsequently following the curve of the lateral sinus from the mastoid process to the external occipital protuberance.

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[1] Reid's base-line is a line drawn around the skull, starting in front at the lower border of the orbit and passing through the central point of the external auditory meatus.

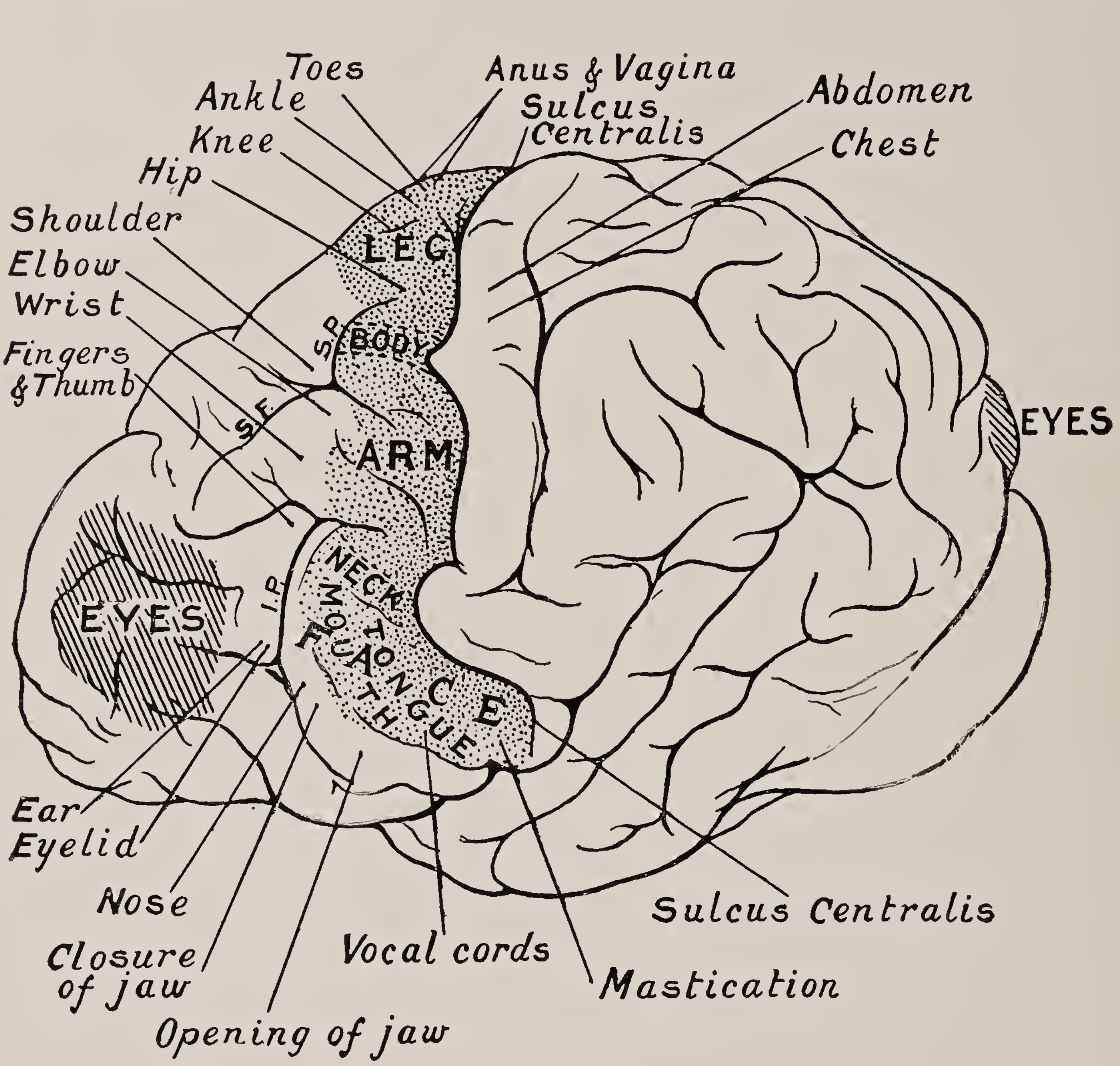

FIG. 189. THE MOTOR AREA AND ITS SUBDIVISIONS ON THE LATERAL ASPECT OF THE CEREBRUM OF THE CHIMPANZEE. (*Sherrington and Grünbaum.*)

The Sylvian point and fissure. The Sylvian point represents the site of divergence of the three limbs of the Sylvian fissure. It lies 1¼ inches behind the malar tubercle and 1½ inches above the upper border of the zygoma. The main posterior horizontal limb passes backwards and upwards to a second point situated ¾ inch below the parietal prominence.

The vertical limb is directed upwards for about 1 inch, whilst the anterior horizontal limb passes forwards for about the same distance.

The fissure of Rolando. This, from a surgical point of view, the most important fissure of the brain, is represented as follows: A point is taken in the median antero-posterior line which lies ½ inch behind the mid-point between nasion and inion, and from this point a line is drawn, for 3½ to 4 inches, towards the mid-point of the zygoma. This line is inclined to the median antero-posterior line at an angle of 67½° (three-quarters of a right angle).

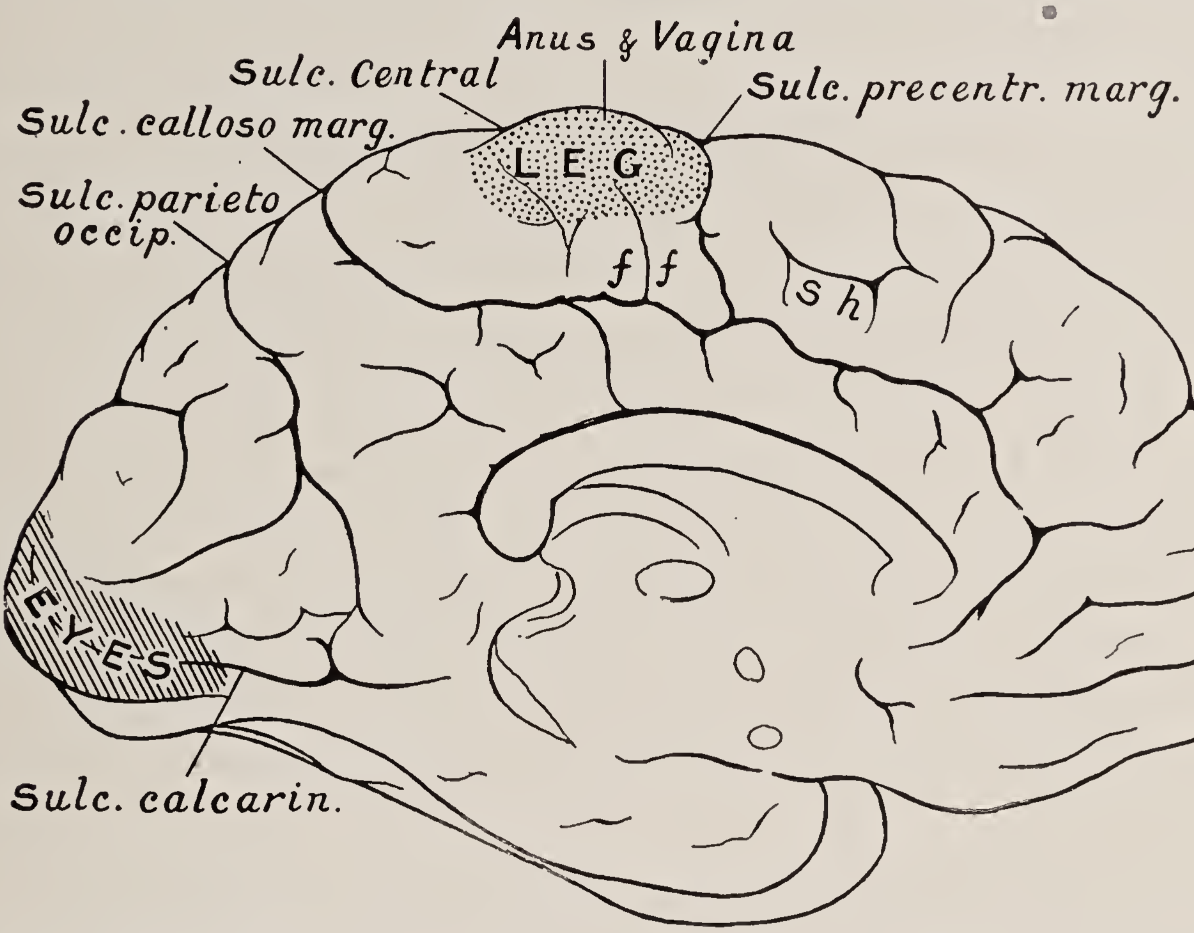

Fig. 190. The Motor Areas and Centres on the Mesial Aspect of the Cerebrum of the Chimpanzee. (*Sherrington and Grünbaum.*)

The parieto-occipital and first temporo-sphenoidal fissures. In the representation of these two fissures, two points require to be determined—the malar tubercle and the lambda. Allusion has already been made to the former; the latter is usually readily located as the point of intersection of the parietal and lambdoid sutures. A line uniting these two points corresponds in its middle third to the temporo-sphenoidal fissure, and in its posterior inch or so to the external parieto-occipital sulcus, a fissure separating the occipital and parietal lobes of the brain.

The cortical motor and sensory areas. The researches of Sherrington and Grünbaum,[1] Campbell,[2] and others tend to show that the cortical motor areas are situated entirely anterior to the central fissure or fissure of Rolando, extending above slightly on to the mesial aspect of the brain, and spreading in the downward direction practically to the fissure of Sylvius. In the anterior direction there is no absolute line of demarcation, the motor region spreading slightly, by means of gyri annectantes, on to that part of the brain which lies immediately anterior to the precentral sulcus. The motor strip is rather less than ¾ inch in breadth.

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[1] *Proceedings and Philosophic Transactions of the Roy. Soc.*, 1901.

[2] *Localization of Cerebral Function.* Camb. Univ. Press, 1905.

The motor area corresponds, from above downwards, to the movements of the opposite lower extremity (toe to hip), trunk, upper extremity (shoulder to fingers), neck and face. It is a point of some general utility to bear in mind that the temporal crest intervenes approximately between the regions responsible for the movements of the upper extremity (above the crest) and those for the movements of the muscles of the head and neck (below the crest).

On the left side of the head, the motor speech area of Broca corresponds to that part of the brain which lies in the angle between the anterior and posterior horizontal limbs of the fissure of Sylvius.

The ‘ primary registration ’ of ‘ common sensation ’ probably occurs in the post-central gyrus, immediately posterior to the fissure of Rolando. The post-central sensory area occupies a position behind the fissure of Rolando very similar in extent to that occupied by the motor area in front of that fissure.

Primary visual impressions are received in the occipital lobe, more especially on the mesial aspect thereof, and auditory impulses in the first temporo-sphenoidal lobe.

In a work dealing with Operative Surgery, it is quite unnecessary to enter into further detail with regard to cerebral localization, and for a complete account of the investigations which have been carried out on the cortical motor and sensory areas the reader is referred to the works of Sherrington and Grünbaum and Campbell.

CHAPTER II

THE SPECIAL TECHNIQUE OF OPERATIONS UPON THE SKULL AND BRAIN

GENERAL CONSIDERATIONS

In order to avoid recapitulation, it will be convenient to group together the various details to which it will be necessary to allude in connexion with the special technique of operations upon the skull and brain. The advantage of such a method will become apparent when it is realized that, not infrequently, the difficulty of diagnosis is so great that the surgeon is called upon to carry out an extensive operation when all preliminary considerations pointed to one of a much more simple nature: insomuch as the success of the operation so often hinges on the more minute preparatory and operative details, the same preparation and the same care must be devoted to a comparatively simple case as to one in which the surgeon is prepared to devote much time and much thought.

Preparatory treatment. A considerable difference of opinion exists with regard to the extent to which the scalp should be shaved and the time at which this procedure should be carried out. Some surgeons advocate that the head should be completely shaved two or three days previous to the operation, and that, during the intervening time, fomentations should be applied—a method both inconvenient to the patient and unnecessary. Others urge that all shaving and cleansing should be postponed till after anæsthesia has been induced—a method that presents certain disadvantages if one has to deal with a very nervous patient, but materially increasing the time during which the patient is under the influence of the anæsthetic. It would appear, however, that although concessions must be made occasionally, the shaving being restricted to a limited region of the head, all such incomplete methods add to the risk of infection. The surgeon can guarantee more readily an aseptic result after complete shaving of the scalp and eyebrows, this proceeding being carried out on the evening previous to the day of operation, and the scalp protected during the night with a nightcap or dressing.

It is often stated that the scalp is difficult of sterilization. Experience shows, however, that such statements are devoid of all foundation. Good results may be obtained by adopting the following mode of skin purification :—

(1) Shave completely both scalp and eyebrows.

(2) Scrub thoroughly with nail-brush, soap, and hot water.

(3) Rub over with ether to remove the fats, then with a spirit solution of biniodide of mercury (1 in 500), and finally with an aqueous solution of mercury biniodide (1 in 2,000).

During the operation, no strong antiseptics are to be used. Sterilized water or saline solution, at a temperature between 110° and 115° F., suffices.

The anæsthetic. Needless to say it is absolutely essential that the anæsthetic should be administered by an anæsthetist of considerable experience in head operations.

Of the two anæsthetics at our disposal, chloroform is probably the more dangerous, a factor so much appreciated in America that ether is regarded in that country as the anæsthetic of choice. In this country, however, the administration of choloroform is generally approved, insomuch as it lowers the blood pressure, gives rise to a lesser degree of venous oozing, and 'by its essential paralysing action on the nerve-centres causes practically no after-excitement and but moderate headache. It is probably as frequently followed by obstinate sickness, but this depends on many considerations, and primarily on the dose itself' (Horsley [1]).

Furthermore, the danger of collapse during the administration can be avoided to a large extent by reducing to a minimum the quantity of drug used during the later stages of the operation, and by utilizing oxygen in conjunction with the chloroform.

Whether the anæsthetic be administered by the Vernon Harcourt apparatus, a method that regulates the dose used, or by the drop-method, one that presents equal advantages when given by a skilled anæsthetist, it is advisable to have oxygen ready to hand. The administration thereof, in conjunction with the chloroform, aids in the stimulation of the respiratory centres and lessens the venosity of the blood.

The position of the patient. Operations on the skull and brain were formerly carried out when the patient was in the ordinary recumbent position. More recently it has been advocated that the patient should be placed in the sitting position in an ordinary dental chair. This recommendation has been carried out successfully on many occasions for operations on the Gasserian ganglion.[2]

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[1] *Brit. Med. Journ.*, Aug. 25, 1906.

[2] *The Surgical Treatment of Facial Neuralgia* (Jonathan Hutchinson.)

The dental-chair position undoubtedly facilitates the manipulations of the surgeon by diminishing the hæmorrhage, but there is every reason to believe that the risk of shock is increased thereby. An intermediate course between the two extremes is generally to be advocated, the head portion of the operating table being raised in such a manner that the patient's body is inclined to the floor at an angle of about 30 degrees.

The manipulations of the surgeon may be facilitated by the use of some form of head-rest. Cushing recommends a special apparatus supported on a detachable tripod. In operations conducted on the cerebellar and occipital regions, the patient is turned completely on the face, the forehead resting on the head-rest and the shoulders on supports attached to the head of the table. The movements of the chest are unimpeded, and the anæsthetic is readily administered from below.

The precautions against shock. A general anæsthetic lowers the body temperature and results in shock more or less directly proportionate to the time during which the patient is under the influence of the anæsthetic. Moreover, it is almost inevitable that all head-operations should be accompanied by a considerable degree of shock apart from that attributable to the duration of the anæsthetic. Consequently, attention should be paid to the following details in order to diminish this tendency as far as possible:—

(*a*) Half an hour before the operation the patient should receive a hypodermic injection of ¼–½ gr. of morphia.

(*b*) The operating room should not be allowed to fall below a temperature of 70–75° F., and the table should be suitably heated.

(*c*) In all the more serious operations, the extremities should be bandaged firmly, from below upwards, in order to keep up a more or less constant peripheral surface-pressure. Crile [1] recommends, for the regulation of the surface-pressure in general, that the patient should be dressed in a special pneumatic suit which completely encloses the body —a method that is costly, inconvenient, and by no means essential.

(*d*) During the operation it is of the greatest importance that exposed brain should not be allowed to suffer from the cooling effects of the atmosphere. Horsley [2] recommends frequent or constant irrigation with normal saline solution at a temperature between 110° and 115° F. A solution at a lesser temperature merely tends to increase the bleeding, whilst any temperature above 115° F. tends to induce coagulation of the surfaces exposed thereto.

(*e*) The operation must be carried out with the utmost expedition, with a light hand, and with the avoidance of unnecessary hæmorrhage.

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[1] *Annals of Surgery,* vol. xliv, p. 843.

[2] *Brit. Med. Journ.,* August 25, 1906.

The avoidance of hæmorrhage. The measures that have been recommended for the avoidance of unnecessary bleeding may be summarized as follows:—

1. *The preliminary ligature, or temporary closure of the main artery in the neck.* Such measures have been advocated as a preliminary step in the exposure and attempted removal of hæmorrhagic or large brain tumours. Both measures are open to the very serious objection that the necessary handling and manipulation of the brain lays the patient open to the grave risk of secondary œdema and softening of the brain. Crile [1] objects to the preliminary ligature of the vessel and states that the mortality resulting from such procedures may be estimated at about 2 to 3%. He advocates, however, the temporary closure of the artery in suitable cases, and points out that clamps can be applied to the carotids for one hour or more without leading to any unpleasant remote effects. In general, however, it may be concluded that neither of these methods is to be followed.

2. *Sequestration anæmia.* It has also been recommended that as much blood as possible should be confined to the extremities by the application of tourniquets and towels to the arms and thighs in such a manner as to arrest the venous return without interfering with the arterial supply. The distal parts become dusky and swollen, and, after the application of the compression force for five or ten minutes, the softened pulse indicates that the desired result has been attained. The limbs are carefully wrapped up in cotton-wool, and, at the termination of the operation, the tourniquets slowly removed in order to allow of the gradual return of the retained blood to the system in general. This method has been recommended strongly by Dawbarn.[2] Good results are said to have been attained. It would appear, however, that the cases to which this method is applicable must be chosen with the greatest care, for it is obvious that there is some increased risk of inducing cerebral anæmia.

3. *Surface anæmia.* Harvey Cushing [3] recommends the application of a tourniquet around the lower circumference of the scalp with the object of controlling hæmorrhage from the vessels of the scalp. The tourniquet consists merely of a rubber ring, closely resembling Esmarch's tourniquet (see Fig. 191). It is applied over a sheet of gauze which completely covers in the head of the patient. The tourniquet passes from the region of the glabella in front, above or across the ears, to the lower occipital region behind. It will be found, as the ring is tightened

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[1] *Annals of Surgery,* vol. xliv.

[2] *Annals of Surgery,* February, 1907.

[3] *Surgery, Gynæcology, and Obstetrics,* March, 1908.

up, that there is a tendency for the tourniquet to slip downwards over the patient's eyes. This is prevented by a tape which passes from the glabella to the occiput, and is there fastened. This tape also acts as a convenient surface-marking to the line of the superior longitudinal sinus. The formation of the scalp-flap is practically a bloodless procedure, all hæmorrhage from frontal, temporal, and occipital vessels being effectually controlled. Much valuable time is saved thereby, and the surgeon can at once proceed to carry out the further operative procedures. After the completion of the operation, the scalp-flap is approximated and sewn into position by salmon-gut sutures, introduced half an inch away from the margins of the incision and taking up the whole thickness of the scalp. Firm pressure is applied, dressings placed in position, and the tourniquet quickly removed. Cushing recommends that the dressings should be maintained in position by means of starch bandages.

Though the scalp-tourniquet cannot be used in operations conducted through the lower temporal region or on the cerebellar fossa, it is applicable to all other operations.

Cushing's tourniquet, by reason of the excessive diameter of the rubber-tube, is rather cumbersome, and the writer is accustomed to utilize tubing, about the diameter of a full-sized red rubber catheter, passed twice round the head, and secured with a pair of pressure-forceps. The tape is passed over the head, after Cushing's method.

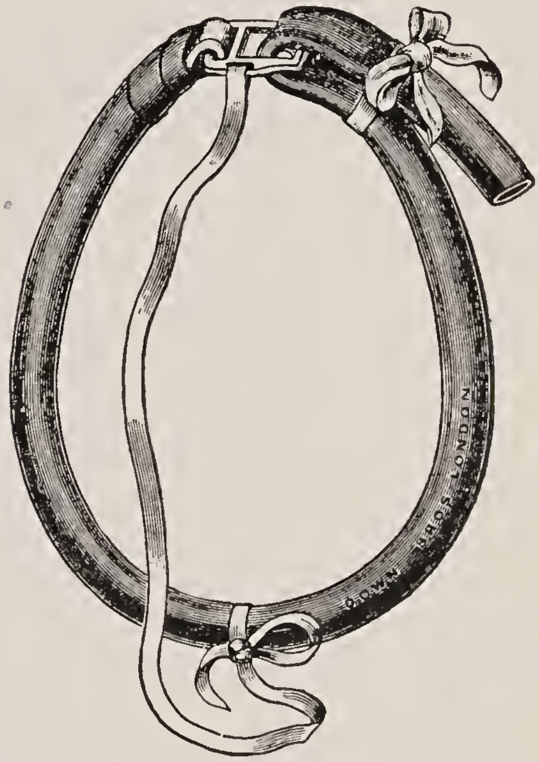

Fig. 191. Harvey Cushing's Scalp-tourniquet.

4. *Tampons.* Hæmorrhage from venous sinuses and from smaller superficial veins may be efficiently controlled by tampons of gauze, though, according to the late Professor von Bergmann,[1] the surgeon is very unwise if he pins his faith on the use of tampons alone. The more special indications for the use of tampons will be indicated in the section dealing with hæmorrhage from venous sinuses.

5. *Point-to-point ligature.* This method is advocated by von Bergmann and Horsley as offering the best means of controlling hæmorrhage. Every vessel is clamped and tied as encountered, whilst those which, from their anatomical position and structure, are incapable of being ligatured in this manner are underrun, with a fully-curved needle threaded with catgut, on either side of the bleeding point or of the proposed site of division.

[1] *System of Practical Surgery,* vol. i.

6. *The cautery.* Bleeding points, so situated that ligatures are unable to be applied, may be sealed with the actual cautery.

Other methods will be enumerated according to the special circumstances of the case, but unnecessary hæmorrhage can usually be prevented by attention to the foregoing details.

Protection of the parts exposed. Either of the following methods may be adopted to protect the exposed parts from infection:—

(*a*) Sterilized towels are stitched to the scalp all round the proposed area of operation. In the region of the forehead the towel is given to the care of an assistant to hold in such a manner that the operative field is cut off from the region over which the anæsthetist has control.

(*b*) The second method has been alluded to in dealing with the question of the application of the scalp-tourniquet, a sheet of gauze being thrown over the head of the patient and maintained in position by the tourniquet. The incisions are carried out by cutting through the gauze. This method is admirably suited to all operations in which the tourniquet itself is applicable.

CRANIECTOMY AND CRANIOTOMY

Craniectomy implies the formation of a scalp-flap and the exposure of the bone, trephining of the skull, and the enlargement of the gap in the skull to the required size and shape.

Craniotomy implies the formation of a flap of scalp and bone in one, the turning back of this osteoplastic flap, and the exposure of dura and brain to an extent proportionate to the size of the bone-flap.

The operative details, and the indications for each of these two methods, require further consideration.

CRANIECTOMY

In the formation of the scalp-flap, the surgeon will naturally be guided by his estimate of the part which it is desired to expose. In all cases, however, the flap must be so framed as to receive the best available blood-supply, and, although the arterial supply to the scalp is everywhere fairly free, yet it is usually advisable to form the flap in such a manner that it will receive along its base the superficial temporal or occipital vessels.

Operation. The point of the knife is entered at one extremity of the proposed flap, carried down to the bone, and the incision completed with a single sweep. If the scalp-tourniquet be used, there is no bleeding. Under other circumstances, hæmorrhage may be controlled during the formation of the flap by digital pressure applied over the base of the zygoma (superficial temporal arteries) and over the lower occipital region (occipital vessels). All bleeding points should be clamped and tied at once, preferably with fine catgut.

Those clamps which are applied along the free margin of the flap may be allowed to remain till the termination of the operation, as they act as convenient retractors of the scalp-flap.

The pericranium is usually included in the scalp-flap. This is by no means essential, and, under certain circumstances, should be omitted (see p. 386).

Trephining. It is interesting to note the divergence of opinion with regard to the use of the hand-trephine. This instrument is absolutely condemned by some surgeons interested in cranio-cerebral surgery, especially by French and American surgeons. For instance, H. C. Masland[1] writes as follows: ‘The hand-trephine requires but little notice. Its tendency, with the greatest care, to injure the dura or even the brain substance, is well known to us all. It destroys the vitality of the bone button, and makes an opening restricted to the diameter of the trephine. It is tiresome, dirty, and practically abandoned by advanced cranial surgeons.’

Contrast now the above statement with the following: ‘This operation (hand-trephining) is characterized by safety, easy execution, and the exactness and rapidity with which the bones of the vault of the skull may be perforated without producing concussion’ (von Bergmann[2]).

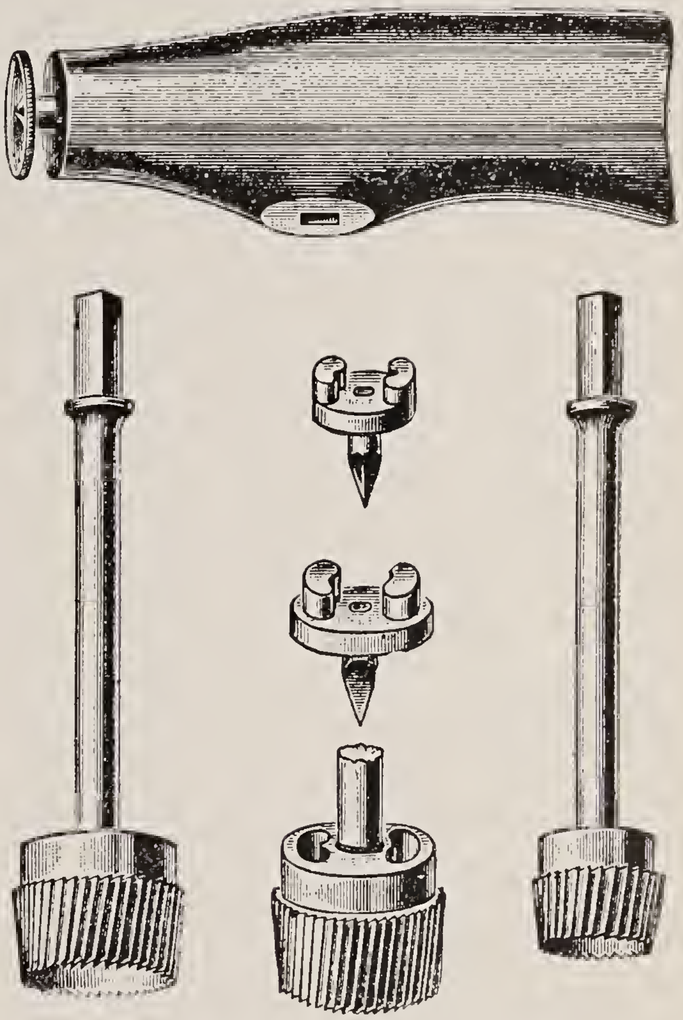

Fig. 192. The Hand-trephine.

And the following: ‘After experience of saws, circular or straight, and trephines driven by electromotors, I find that the foregoing principle (the removal of the bone with the least possible pressure on the brain) can be most readily and quickly fulfilled by first removing a disk with the hand-trephine’ (Sir Victor Horsley[3]).

Horsley’s statement concludes by advocating, after the preliminary trephining, the application of the saw and bone-forceps for the further removal of bone, but the main question at issue as to the cleanliness, safety, and general excellence of the hand-trephine will readily be settled in favour of this instrument by all those who have experience in hand-trephining.

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[1] *Annals of Surgery*, vol. xliv, p. 161.

[2] *System of Practical Surgery*, vol. i, p. 326.

[3] *Brit. Med. Journ.*, August 25, 1906, p. 419.

In order, however, that the instrument should be judged on its true merits, and in a fair spirit, it is essential that the right instrument should be used in the right manner.

Trephines are of many patterns, but the one that gives the most satisfactory results must possess certain characteristics.

(*a*) It should be of simple mechanism and strong.

(*b*) The handle should be of good size, shaped so as to fit the hand that grasps it, and weighing about 5 ounces. The shaft and head are either made in one, or so interlocked that no independent movement is possible, the movements of the handle being therefore directly transmitted to the shaft and head.

(*c*) The hollow head should be sharply toothed on the inferior or biting edge and bevelled externally, in continuity with the teeth, for a distance of ½ inch. The external bevelling is arranged obliquely so that the actual cutting process is brought about during the act of supination of the forearm. In shape, the head should be conical, tapering slightly towards the cutting edge; the bone disk is thus more readily removed and there is no possibility of the instrument slipping suddenly as the bone is divided and injuring the dura mater.

(*d*) The pin of the trephine should project for about 2 centimetres and should be capable of ready removal. A pattern (see Fig. 192) which suits all requirements presents on the upper surface of the pin two kidney-shaped projections which fit into corresponding depressions on the under surface of the head of the trephine.

Trephines should be kept in three sizes—diameter ½ inch, 1 inch, and 1½ inches respectively. The intermediate size is the instrument advocated for ordinary trephining. The smallest should be used in the formation of the osteoplastic flap (see p. 375), and the largest for the removal of a disk of bone which includes within its circumference the area involved in a punctured fracture (see p. 389). The full-sized instrument may also be used in certain birth fractures (see p. 394).

The site of trephining having been determined, the scalp-flap turned down to its base, and the pericranium stripped away from the region of bone which it is desired to remove, the pin of the trephine is applied to the centre of that area. The trephine must be applied absolutely at right angles to the surface of the bone, and a grip on the bone attained before the pin is discarded. As soon as the teeth of the trephine attain the necessary grip, and as soon as a circle of uniform depth is defined, the pin can be discarded, the trephine again introduced, and the operation continued.

The groove is deepened progressively, but at no period of the operation should much manual strength be applied. The movements of the trephine must always be kept under perfect control, and it should be borne in mind that the obliquity in the arrangement of the teeth only permits of the cutting process during the act of supination, so that it is only during that act that muscular effort is required.

It has been elsewhere stated that every skull should be explored as if it were extremely thin. This advice is possibly applicable to the novice, but a little experience in trephining will soon enable the operator to gauge accurately the depth to which the trephine has reached and to estimate the further manipulations necessary.

The firm nature of the external table will be readily appreciated; as soon as this resistance is overcome the trephine will be felt to bite through a softer structure, whilst the increased bone-dust and the venous oozing will make evident the fact that the instrument is cutting its way through the diploic tissue. Greater resistance is again encountered on meeting the internal table, warning the operator that the time has arrived when greater care must be exercised. At this stage the bone-dust must be periodically removed from the trephine circle, and the teeth of the trephine cleansed with an ordinary sterilized nail-brush. The depth of the groove must also be determined by the aid of some suitable instrument, in order that the surgeon may be certain that the circle is of uniform depth, or of that depth which is suited to the particular part of the skull on which the operation is being carried out. Any irregularities in the depth may be remedied by the application of a slightly increased pressure over the required section of the trephine circle.

If, after examination with some blunt exploring instrument, it be found that the bone is completely cut through on one side of the circle only, the trephine should be applied gently to the undivided part.

A useful method of demonstrating that the disk is almost free and ready for removal may be obtained by digital pressure, the disk giving to the pressure and showing that it is ready for elevation.

No doubt the rapid complete circumferential division of the bone is calculated to impress the onlooker, but, unless the operator has great experience in trephining and possesses complete control over the trephine, all such attempts are to be condemned on account of the attendant grave risk of damage to meningeal vessels and dura mater.

On the other hand, the bone-elevator (see Fig. 193) must not be used till the operator is satisfied that the complete disk is ready for removal, the premature use of the elevator merely resulting in the splitting off of the external table and in further complication.

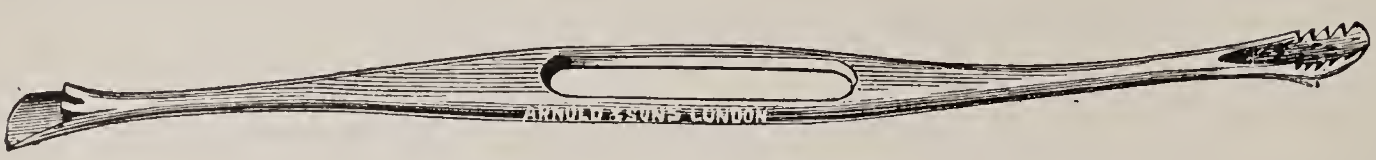

Fig. 193. Horsley's Disk or Bone Elevator.

Especial care is required in operating in the temporal and cerebellar regions, where, owing to the absence of the diploic tissue, the two blades of the skull are practically in apposition; the same warning applies to all operations in children, not only on account of the thinness of the skull, but also because of the greater adherence of the dura mater to the overlying bone.

Too much stress cannot be laid on the necessity of avoiding damage to the meningeal arteries and dura mater, for such injuries frequently upset the whole plan of operation.

The hand-trephine undoubtedly possesses one great disadvantage. It is somewhat slow in manipulation, and, in operations carried out upon thick skulls, tends to tire the muscles of the operator's forearm and hand. Its comparative safety over all electrically or mechanically driven instruments acts, however, as its strongest recommendation, whilst the tiring effects can be diminished either by lowering the operating table, or by the surgeon standing on a stool, in either of which cases the trephining is carried out practically with the straight arm, the shoulder muscles thereby relieving the muscular tension of the forearm and hand. Under no circumstances must any body weight be transferred to the trephine.

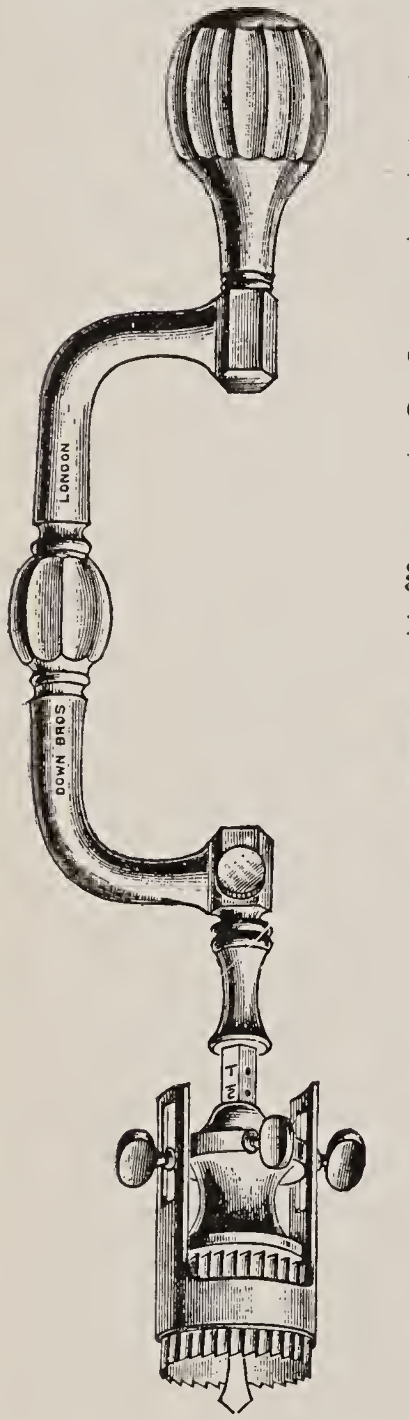

Fig. 194. Trephine used after the Style of a Carpenter's Brace.

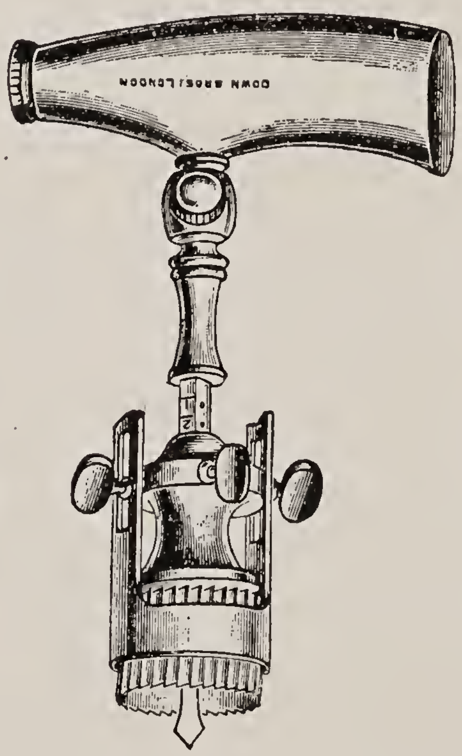

Fig. 195. The Same Instrument used as a Hand-trephine.

With the object of saving time and energy, various trephines have been invented, and allusion may be made to the two following types:—

(*a*) A trephine constructed after the type of the carpenter's brace (see Fig. 194): an instrument liable to get out of order, less readily sterilized, and, above all, less readily controlled by the operator.

(*b*) Trephines driven by electric or hand motors: instruments liable to fail at the critical moment, cumbersome, and certainly more prone to damage meningeal vessels and dura. Further disadvantages will be alluded to in dealing with the formation of the osteoplastic flap (see p. 381).

The enlargement of the trephine hole to the required size and shape. Previous to any enlargement of the trephine hole, the dura mater must be separated carefully from the overlying bone with the aid of Horsley's or other dural separator (see Fig. 196).

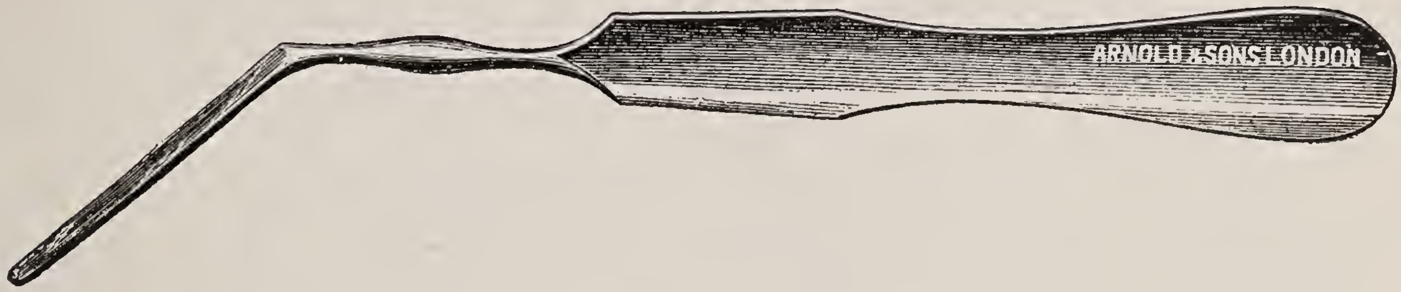

FIG. 196. HORSLEY'S DURAL SEPARATOR.

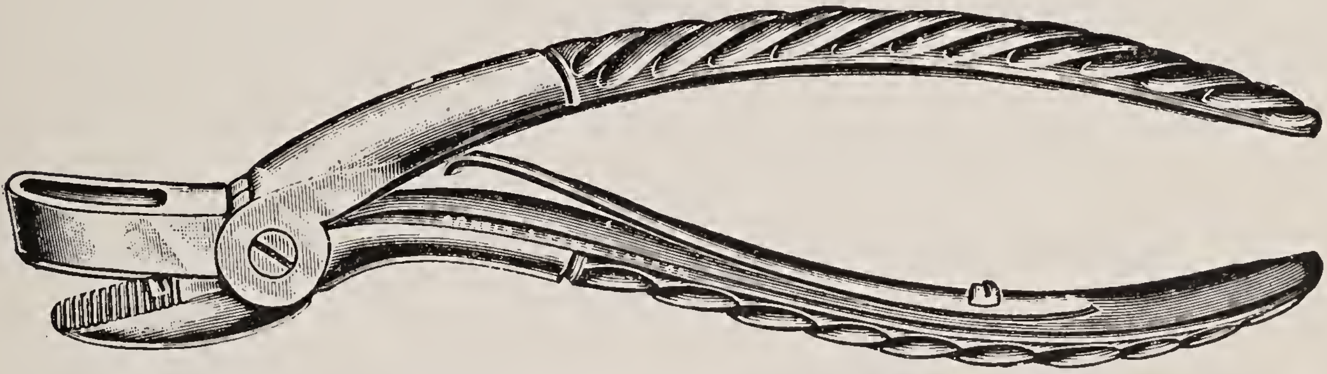

FIG. 197. KEEN-HOFFMANN CRANIECTOMY FORCEPS.

Of the many patterns of craniectomy forceps that have been invented the following four may be accepted as affording the best types and as sufficing for all operative procedures:—

The Keen-Hoffmann forceps are of great general utility in the enlargement of the gap and are capable of biting away fragments of bone in both thick and thin skulls. The visceral blade is introduced between the dura and the bone and the *morcellement* carried out as required. It is essential that the operator should be content with the removal of small portions of bone at each bite of the instrument. A slight outward leverage aids in the process.

Lane's fulcrum forceps. The advantages of this instrument (see

Fig. 198) are best illustrated by quoting from the *inventor's description:*[1] 'The instrument is seen to consist of two blades moving on one another around a transverse axis. The promixal blade ends in a deeply serrated surface, which rests upon the bone immediately beyond the portion which is to be removed. It acts as a fulcrum around which the forceps move in a vertical plane when the handles are approximated and depressed. The distal blade is claw-shaped, presenting a sharp cutting edge. This is introduced beneath the piece of bone which the surgeon intends to remove, and when the handles are forcibly approximated and depressed this sharp edge tears through the bone with such an amount of power as can be readily understood from the fact that the length of the short arm of the lever, which is one of the first order, corresponds to the varying, though always narrow, interval which exists between the ends of the two blades when in use, while for all practical purposes the force that can be brought to bear upon the long arm is unlimited.'

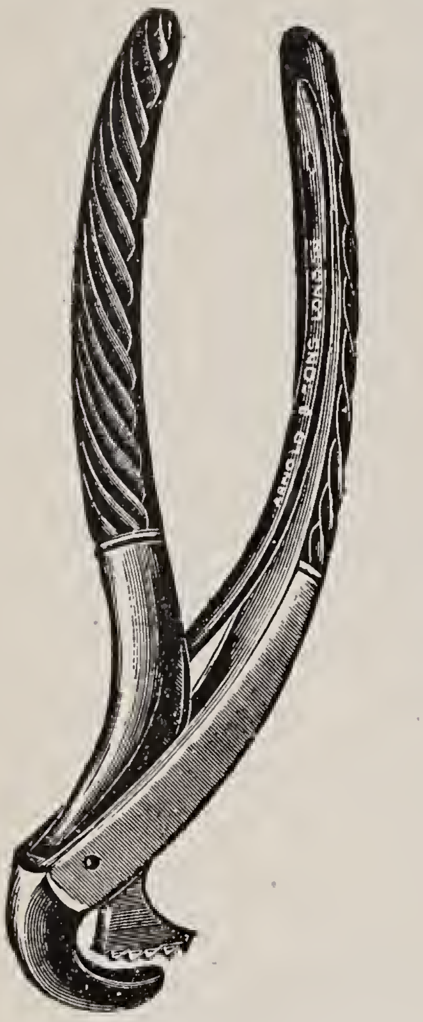
Fig. 198. Lane's Fulcrum Craniectomy Forceps.

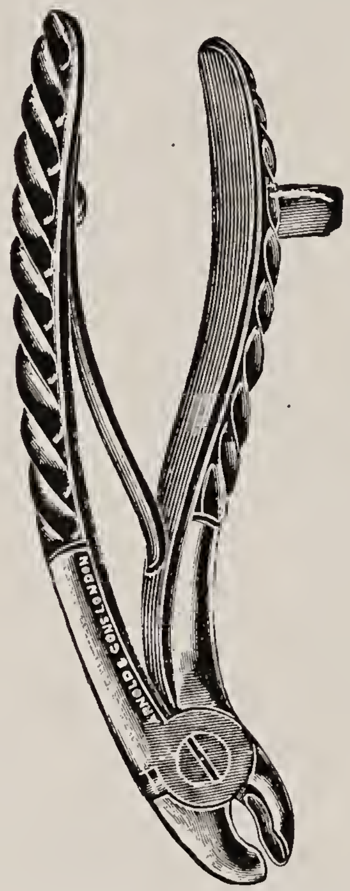
Fig. 199. Horsley's Gouge Forceps.

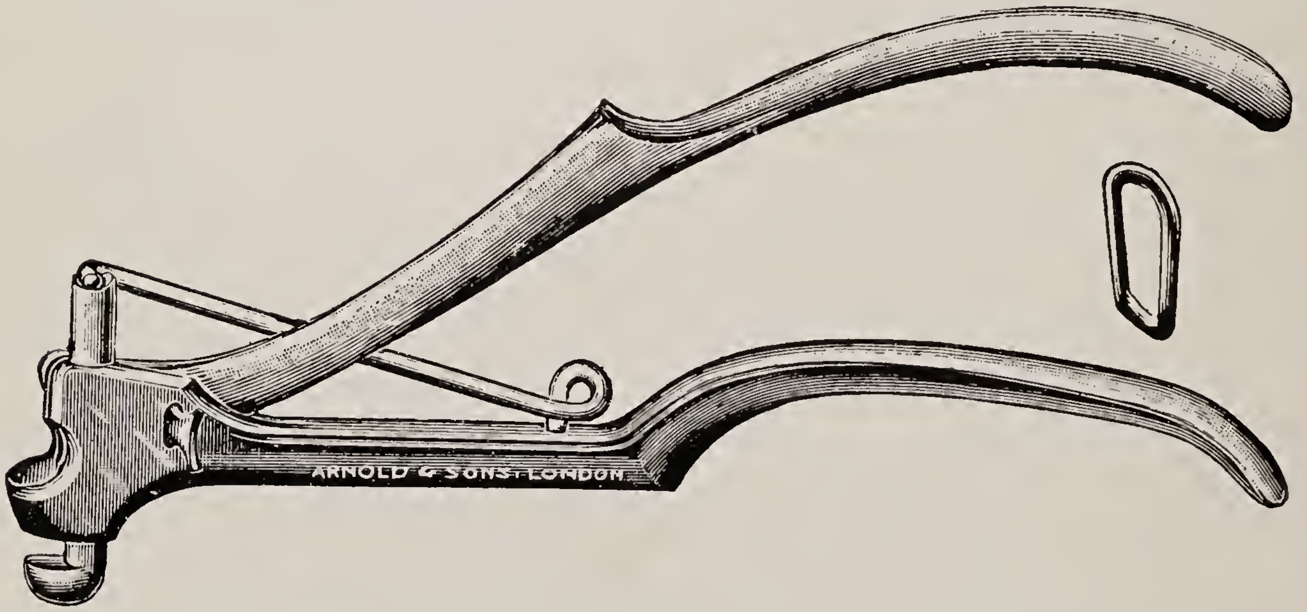

Fig. 200. De Vilbiss's Craniectomy Forceps.

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[1] *Lancet,* November 10, 1894.

These forceps are eminently suited for the rapid removal of large fragments of bone.

Horsley's gouge or nibbling forceps (see Fig. 199) are mainly utilized in the smoothing and refreshing of the rough edge of bone that is left after the application of either of the above-mentioned forceps. Also of use in *morcellement* of the thinner portions of the skull, *e.g.* the squamous portion of the temporal bone and cerebellar fossa.

De Vilbiss's forceps. The pattern shown in Fig. 200 enables the operator to cut rapidly a narrow channel in the bone. The instrument may be used with advantage in the formation of the osteoplastic flap (see p. 380).

CRANIOTOMY

Craniotomy, or osteoplastic resection of the skull, was carried out first by Wagner.[1] The method has for its main object the formation of a combined flap of scalp and bone, and the exposure of the dura and brain to an extent directly proportionate to the size of the bone-flap. The flap receives a good blood-supply, and is capable of ready replacement.

In deciding, however, between craniectomy and craniotomy in any given case, the relative dangers and disadvantages of the two operations must be considered.

The main disadvantages of the osteoplastic flap are as follows:—

(*a*) The attendant shock is often considerable.

(*b*) The formation of the flap, even by skilled hands, is a procedure that requires considerable time—seldom less than half an hour, and, in the presence of complications, often much longer.

(*c*) There is undoubtedly an increased risk of injuring meningeal vessels and dura mater, the former complication possibly necessitating such use of the craniectomy forceps in order to expose fully the bleeding point that the flap loses its main advantage, namely, accurate reposition. In some few cases it has been found necessary to remove the flap altogether.

(*d*) The formation of the flap may merely suffice to expose a part of the tumour or blood-cyst, the craniectomy forceps being again called into requisition.

(*e*) The replacement of the flap occasionally prevents the establishment of adequate drainage, and such a procedure is essential after the discovery of pus, after the removal of large and hæmorrhagic brain-tumours, and after the evacuation of a subdural hæmatoma or an arachnoid cyst.

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[1] 'Die temporäre Resection des Schädeldachs,' *Centralb. für Chirurgie*, 1889, vol. xvi.

Many of the above-mentioned disadvantages may be obviated by accurate diagnosis and by skilful operation. Even under the most favourable circumstances, however, it must be acknowledged that craniotomy has further restrictions.

It is contra-indicated in most cases of intracranial hæmorrhage. For instance, in middle meningeal hæmorrhage, the formation of an osteoplastic flap gives a needlessly large exposure and adds considerably to the time during which the patient is under the anæsthetic. Furthermore, insomuch as most cases of intracranial hæmorrhage are associated with a fracture, perhaps comminuted, it is quite impossible, under such circumstances, to form a flap of this nature.

It is contra-indicated in those cases of Jacksonian epilepsy which result from deficiency in the bone, from bone depression, and from thickening and matting of membranes. In such cases, craniectomy is to be preferred to craniotomy, the deficiency in the bone being rectified, if necessary, at a later date.

It is contra-indicated in operations conducted for the exposure of the Gasserian ganglion, and for the cerebellum. In both these instances even craniectomy allows but limited exposure, whilst the presence of a craniotomy flap would restrict still further the operative field. The flap method has been practically abandoned for the operations in question. It may be added also that the thin cerebellar walls do not lend themselves readily to the formation of an osteoplastic flap.

It should be stated perhaps that some of these contra-indications are not accepted by many Continental and American surgeons. In this country, however, the use of the osteoplastic flap is more or less restricted to those cases in which a reasonably certain diagnosis can be made that the patient is suffering from a tumour of the cortex or meninges. The method can also be used with advantage in those cases in which, owing to some uncertainty in the diagnosis, it is desirable to expose a large superficial area of the cerebral cortex. If an incorrect diagnosis be made and no tumour found, the flap can be replaced without that resultant deformity which exists necessarily after craniectomy.

Furthermore, even in the event of the discovery of a localized subdural hæmatoma or arachnoid cyst, for both of which conditions drainage is usually required, the flap may be replaced and one of the trephine holes utilized for the emergence of the drainage tube.

The general advantages of the osteoplastic flap are obvious, and if the operation be restricted to suitable cases, and carried out by experienced hands, the results are very satisfactory. This is especially the case when the further manipulation of dura and brain is postponed for a few days (see p. 427).

Operation. The preliminary details of the operation are practically identical, whatever methods be adopted for the division of the bone.

A large ∇-shaped incision is made in such a manner that the three limbs enclose the area which requires exposure. The knife is entered at one extremity and carried down to the bone, and the three incisions rapidly completed one after the other. There is no bleeding worth mentioning if the scalp-tourniquet be used. The incised pericranium is then stripped away from the bone, in a direction away from the centre of the flap, for about half an inch. At the anterior and posterior terminations of the incision, and at the two angles of the flap, the scalp and pericranium are pushed aside so as to allow of the application of a half-inch trephine. At these four points holes are bored and the four disks of bone removed. This trephining must be carried out with all the usual precautions (see p. 371).

The subsequent procedures vary according to the measures adopted for the division of the bone. This may be carried out with Gigli's wire saw, with Doyen's craniotomy saw, with the hammer and chisel, or by means of burrs and saws driven with electricity. Gigli's saw divides the bone from *within outwards,* whilst the reverse is the case with regard to all other methods. It is obvious that, however skilful the operator may be, the cutting of the bone from without inwards increases the risk of causing damage to the underlying structures. Gigli's method therefore presents distinct advantages.

The formation of the bone-flap with Gigli's saw. The dura mater is separated from the bone between the two anterior, the two upper, and the two posterior trephine holes. This is carried out either with Gigli's director or with Horsley's dural separator. Gigli's director (see Fig. 204) is passed between the two upper trephine holes, the handle well depressed and the head kept in contact with the bone. When presenting through the more distal hole, the whalebone guide is passed along the groove of the director, and the special saw (see Fig. 205) attached to the holes at the apex of the guide with a fine silk ligature. The guide is then withdrawn, and the saw after it, until the latter emerges from the two trephine holes and lies, throughout its course, between the director and the bone.

The handles are then affixed to the saw, and the bone divided between the two holes in an oblique manner so that the flap, when replaced, rests on a ledge of bone. The action of the saw generates so much heat that the assistant must be instructed to keep up continuous irrigation; the sawing process itself is carried out by steady side-to-side traction, without jerks. If the saw breaks, a special handle may be attached, thus obviating the necessity of introducing a fresh saw.

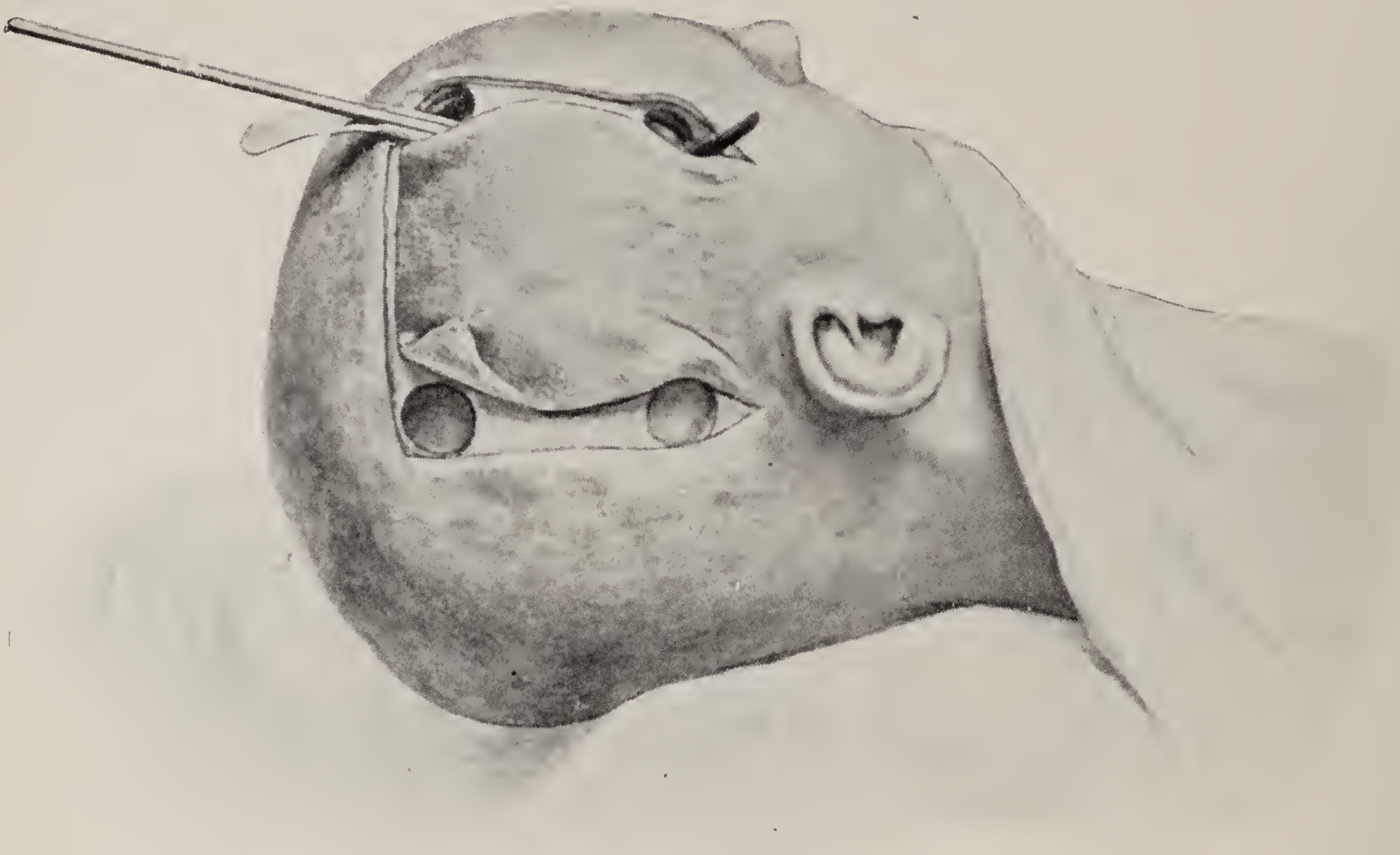

FIG. 201. THE OSTEOPLASTIC FLAP. *First stage.* Shows the four trephine holes and Gigli's director in position.

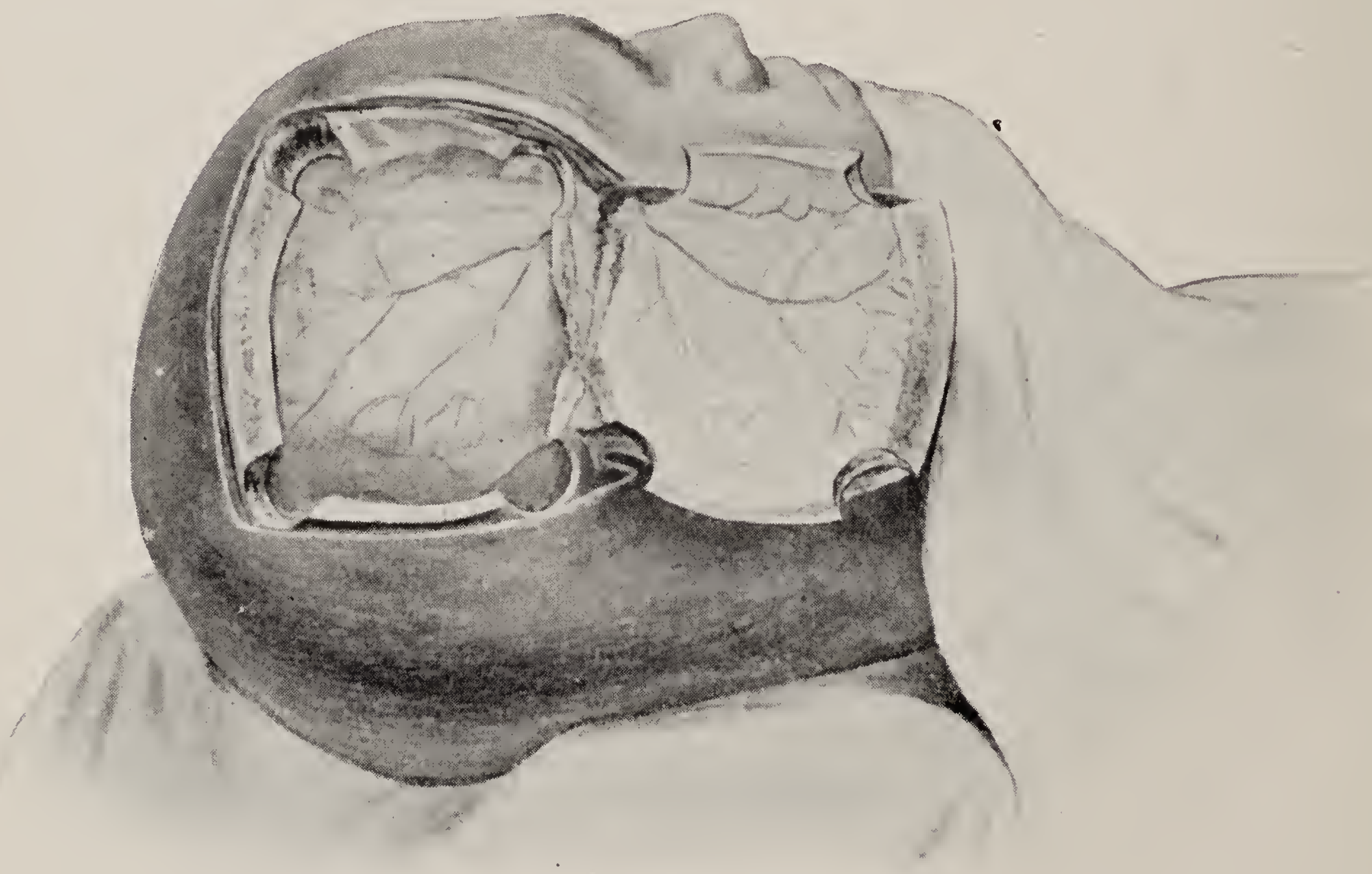

FIG. 202. THE OSTEOPLASTIC FLAP. *Second stage.* Shows the osteoplastic flap turned back and the exposure of the dura mater.

The division of the bone is completed between the two upper, between the two anterior, and between the two posterior holes, after which the saw is introduced between the two lower holes. In this last case, however, it is only necessary to weaken the bone by the division of the internal table, and, in order to fulfil this object, the saw should be worked in a more horizontal plane. The internal table having been divided, the flap is levered outwards by means of two periosteal elevators introduced beneath the bone-flap at its upper part. The dura is carefully stripped away, and the flap finally broken across at its base by grasping the bone between the fingers and sharply snapping it across. The flap is enveloped in gauze, and held aside till the termination of the operation.

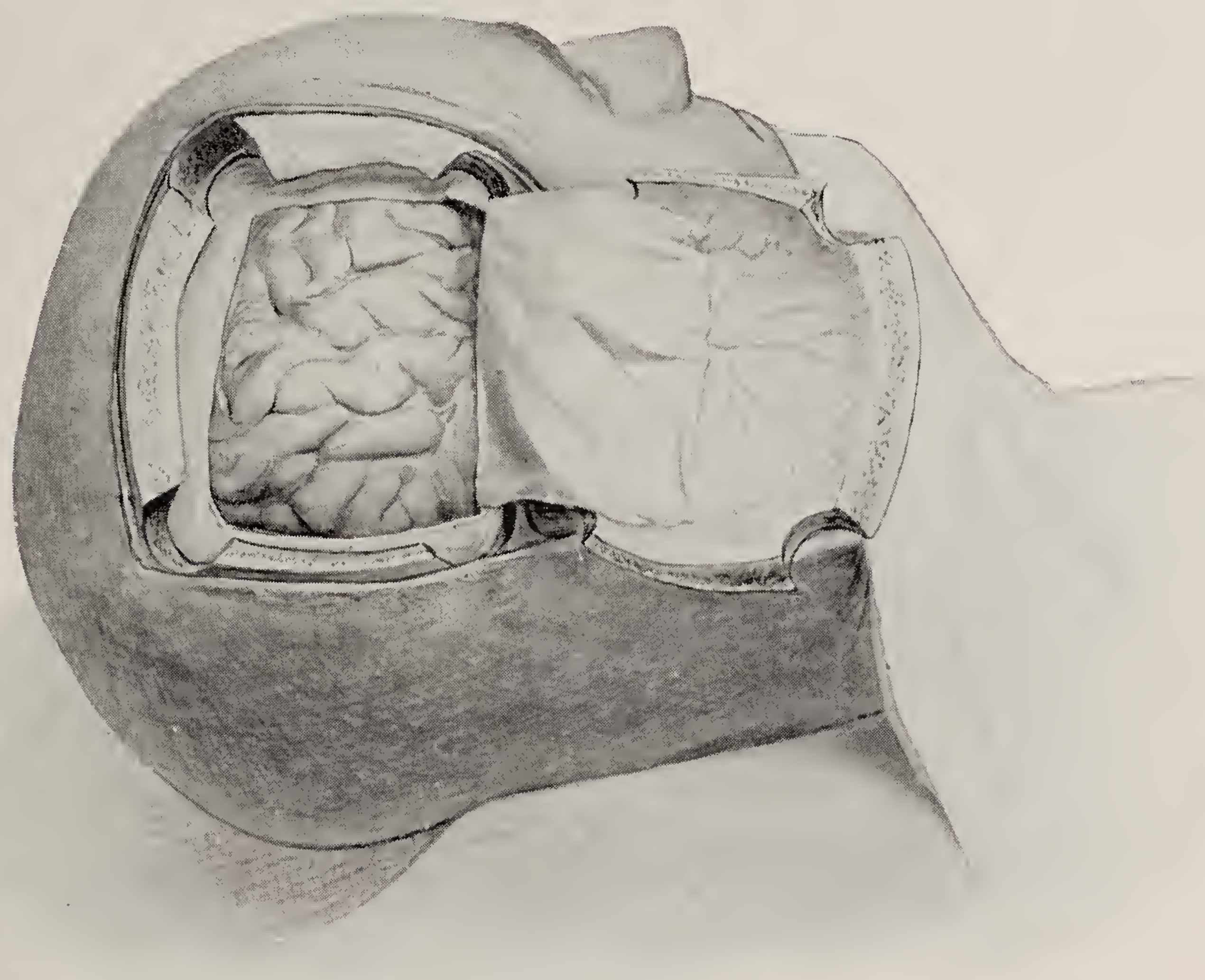

FIG. 203. THE OSTEOPLASTIC FLAP. *Third stage.* Shows the turning back of the dura mater and the exposure of the brain.

The base of the flap should then be examined with the object of seeing whether any of the underlying meningeal arteries have been damaged. Some difficulty may be experienced in stopping the hæmorrhage from such a source, and it may become necessary to strip the dura further away from the bone and utilize the craniectomy forceps before the bleeding point can be secured. In some few cases it has been found necessary to remove the flap altogether. Such a course, however, should very rarely become necessary if due care be exercised in the fracture of the base of the flap.

Time may sometimes be economized by making trephine holes only at the two upper angles of the flap. These are connected horizontally by Gigli's saw, while the vertical cuts are made with De Vilbiss's forceps (see Fig. 200). At the lower angles of the flap the forceps may be so manipulated as to round off the corners and weaken the base of the flap. Fracture is readily produced.

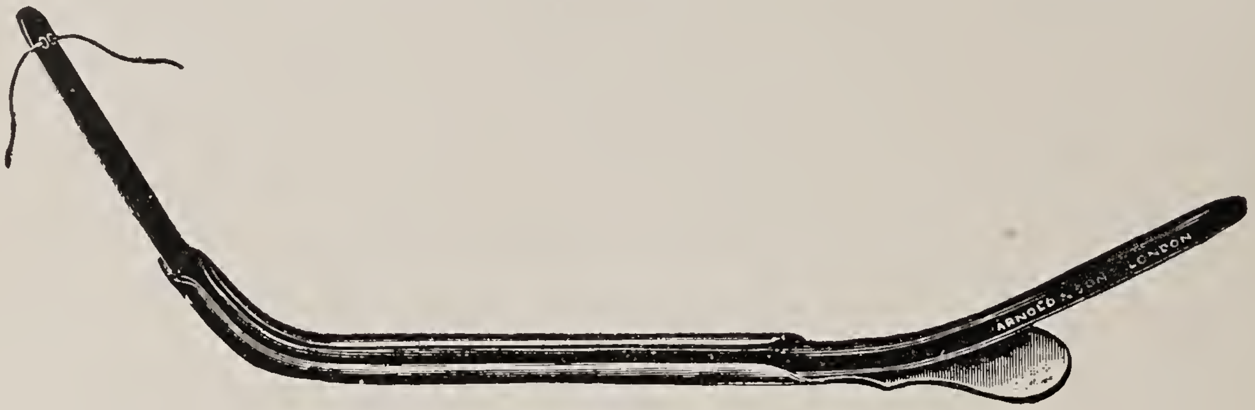

Fig. 204. Gigli's Director and Guide.

The formation of the flap with the aid of the hand-saw, hammer, and chisel. In place of Gigli's saw, the four holes can be united with the hand-saw, preferably with that pattern devised by Doyen (see Fig. 206), in which the depth of the penetrating edge is regulated at will by a graduated guard. The complete division of the whole thickness of the skull by means of the saw alone is conducive to dural injury, and it is therefore advisable to saw through the external table and diploe alone, the final division being completed with the craniotomy chisel (see Fig. 207) and hammer. The projecting arm of the chisel is kept firmly against the overlying bone by firm depression of the handle, the dura being thus separated from the bone and also protected from injury at the same time. With a few taps of the hammer, the inner or vitreous table of the skull is split along the desired line, and the flap turned back as before.

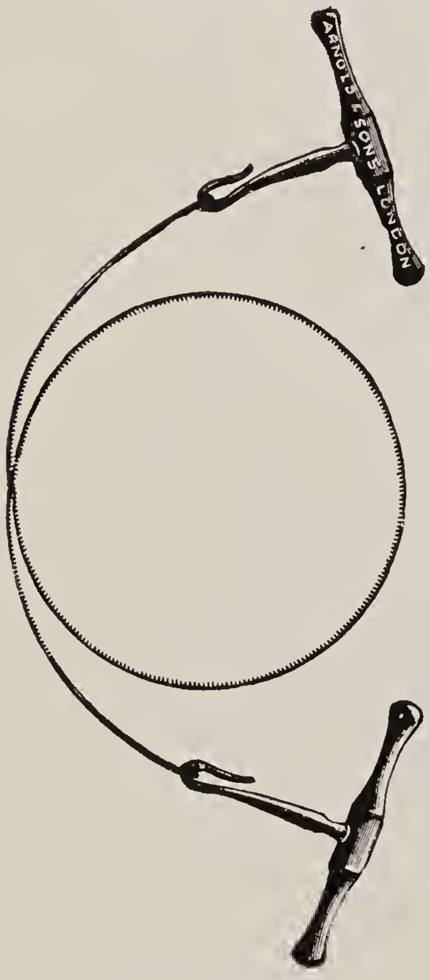

Fig. 205.
Gigli's Wire Saw.

This method possesses no advantages over the one previously described, whilst, on the other hand, there is an undoubted liability to dural and meningeal injury: firstly, because that complication is prone to occur in all methods where the bone section is carried out from without inwards, and secondly, because skulls, even of normal individuals, vary in thickness to an extraordinary degree. Furthermore, the chisel tends to split off small fragments of bone which may possibly tear the dura, and finally, the application of the hammer must necessarily result in mild concussion and correspondingly add to the shock of the operation.

The formation of the-flap with the aid of burrs and saws, driven by an electric motor or other means. Many burrs and saws have been recommended, graduated in size and shape according to the region of the skull which is to be opened. Hartley[1] expresses himself well satisfied with 'a small motor trephine of such size and weight that it can be held by the operator himself and allowing of perfect control, both of the cutting tool and of the power. The tools are connected by means of an appropriate chuck directly to the armature, thus obviating all loss of

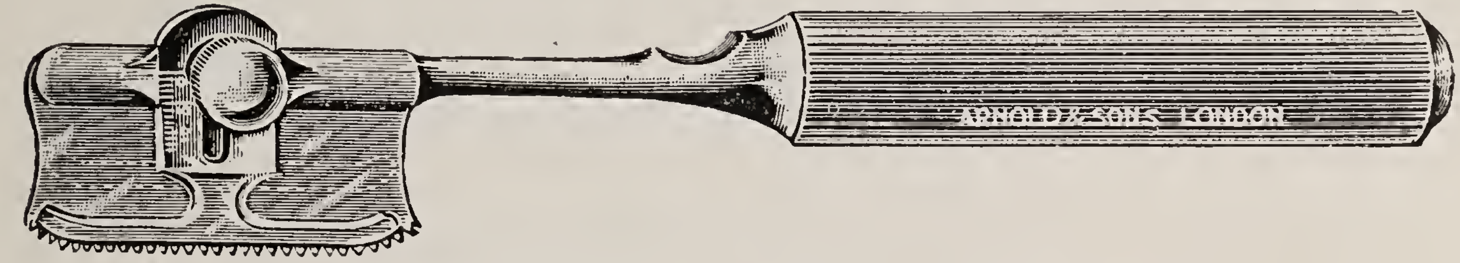

FIG. 206. DOYEN'S GRADUATED SAW.

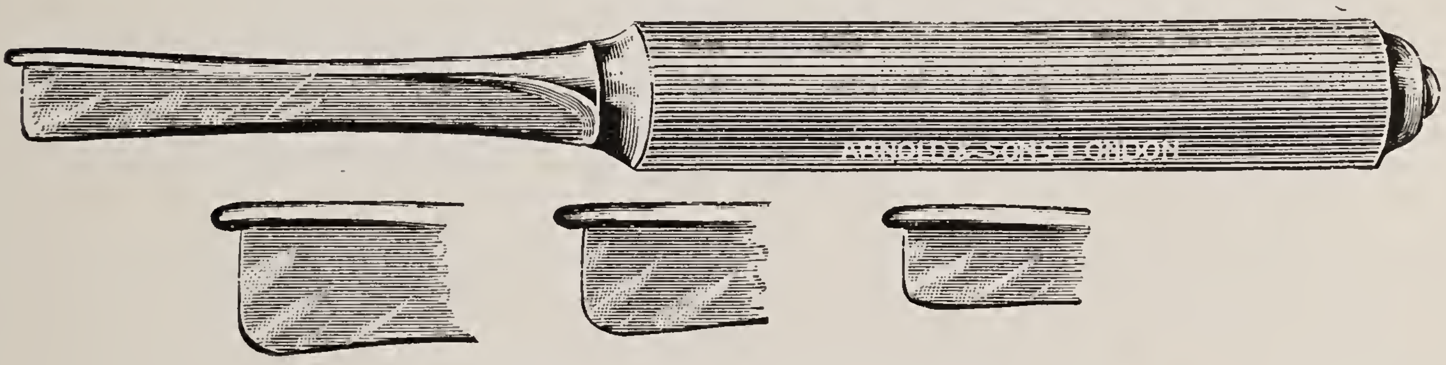

FIG. 207. CRANIOTOMY CHISEL.

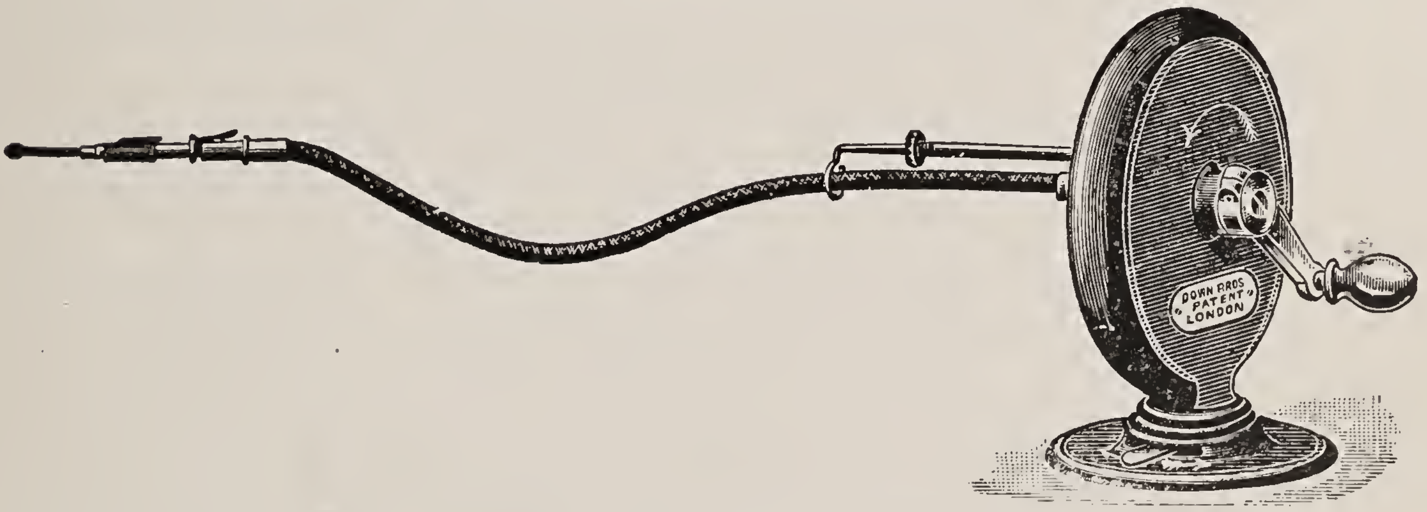

FIG. 208. A HAND-MOTOR. For use with Nicholl's and van Arsdale's saws, drills, &c.

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[1] *Annals of Surgery*, 1907, p. 481.

power when a flexible shaft is used. The trephine holes are cut with the motor trephine, and the guarded saw then introduced, the three sides of the flap being sawn through in such a manner that the final application of the hammer and chisel completes the section of the bone.'

Two instruments received with some favour in this country are Nicholl's guarded saw and van Arsdale's saw. Both of these can be driven by the hand-motor patented by Down Bros. Nicholl's saw is provided with a series of 'guards,' graduated according to the depth of bone required to be penetrated. Van Arsdale's saw cuts in circles of 2½ and 3 inches in diameter (see Figs. 208–10).

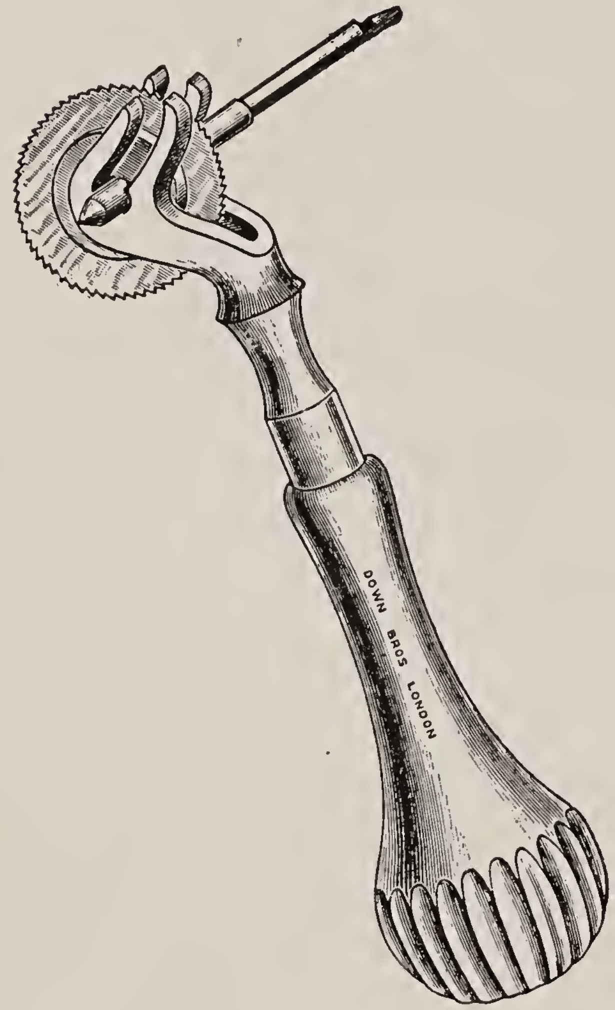

Fig. 209. Nicholl's Guarded Saw.

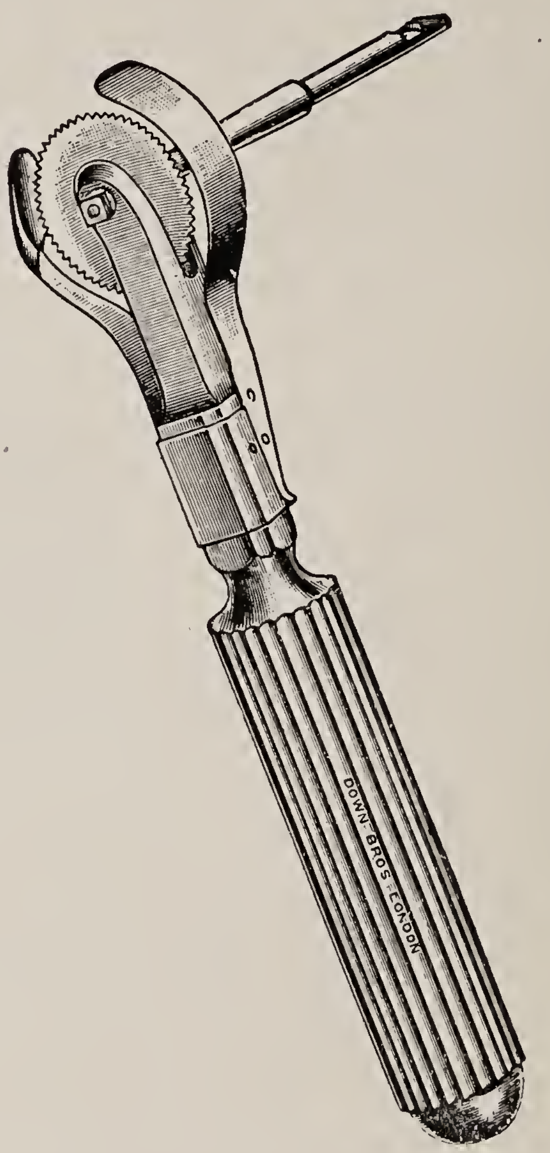

Fig. 210. Van Arsdale's Saw.

The disadvantages of the hammer and chisel, and of all electrical devices, are admirably summed up by Harvey Cushing[1] in the following words: 'Simplicity is a desirable quality in operative technique, but the blows of a mallet, even though transmitted in a glancing manner, are undesirable; and speed, the chief advantage of the motor-driven rotary tools, is invariably a source of danger. It matters little whether an osteoplastic flap can be elevated by one method in seven minutes, or whether another requires twenty; and an operator who persists in taking dangerous corners at high speed will be the cause of a serious or fatal accident some day, whether he is driving an automobile or opening the skull. For in the more rapid operation, should dura or cortex happen to be injured at the time of making the bone-flap, not only is the chance lessened of a successful result, particularly in cases with increased cerebral tension, but also time is actually lost. It is the hare and the tortoise over again.'

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[1] *Surgery, Gynæcology, and Obstetrics,* March, 1908.

The same authority also writes elsewhere: 'Surgeons who use electro-motive force for osteoplastic operations are able to work very rapidly, and if this does not mean added risk of accident it is desirable. However, having witnessed, twice from a Doyen circular saw, and once from a Crile drill, what I regard as a most serious accident—namely, the division of bone and dura at the same time, owing to the fact that the guide of the speeding instrument worked its way through the adherent membrane instead of separating it from the skull—I have clung to the somewhat slower, but certainly less dangerous operation by hand-driven instruments.'

The experience of the writer leads him to the conclusion that the formation of the osteoplastic flap is carried out with the greatest safety to the patient by means of the hand-trephine, Gigli's saw, and De Vilbiss's forceps.

CHAPTER III

OPERATIONS FOR FRACTURES OF THE SKULL

OPERATIONS FOR FRACTURE OF THE VAULT IN ADULTS

Indications. Fractures of the vault of the skull are often classified arbitrarily into two main groups, according to whether operative treatment is necessary or not, the two groups being differentiated sharply from one another. There is, however, no such line of demarcation, for, though in many cases the correct mode of treatment is obvious, yet there are a considerable number of cases in which great difficulty may be experienced in arriving at a conclusion as to whether an operation is advisable or not.

A general review of the indications for operation will show that the adoption of an expectant policy frequently ends in disaster, and there are, furthermore, but few cases on record in which the surgeon had reason to regret the carrying out of operative measures.

In the event of the general condition of the patient being compatible with operation, such treatment is called for urgently in all the following conditions:—

(*a*) All cases of punctured fracture.

(b) All cases of depressed fracture, whether diagnosed by palpation or by inference, whether simple or compound, whether complicated or not.

(*c*) All cases of fracture complicated by extra-dural or localized subdural extravasation of blood.

(*d*) All elevated fractures.

(*e*) All compound fractures.

In all these instances, both from the presence of depressed fragments of bone and from associated injuries to brain and intracranial vessels, it is obvious that no mere expectant policy should be pursued. The surgeon has also to bear in mind the possible development of meningeal infection and the more remote onset of Jacksonian epilepsy, &c. In other words, early and active surgical treatment is imperatively demanded, for it is not only necessary that every effort should be strained to save the patient's life, but that the surgeon should carry out those procedures which will guard most effectually against the more remote possibilities of the injury.

The advisability of operating on simple and uncomplicated fractures. If it can be determined that the fracture, whether fissured, stellate, or comminuted, is simple and uncomplicated by any serious intracranial injury, no active surgical treatment is required. The determination of such conditions is, however, always a matter of considerable difficulty and, from the almost constant presence of an overlying hæmatoma, often quite impossible.

In the general estimation of the case, it should be borne in mind that simple uncomplicated fractures of the vault are decidedly rare. For instance, Dwight,[1] in 145 cases of fractured skull that came to autopsy, found only six in which a fissured and localized fracture of the vault was alone present. It may, of course, be argued that simple and uncomplicated fractures of the vault are seldom fatal, and that all postmortem statistics are fallacious. Experience shows, however, that a force which suffices to fracture the skull almost necessarily results in further injury.

In these doubtful cases, the surgeon is helped greatly in his decision by a general review of the patient's condition, and more especially by the symptoms regarded as exemplifying the clinical conditions of brain concussion, irritation, and compression.

When there is mild 'concussion,' a condition associated usually with no macroscopical lesion of the brain, or at the most with some slight contusion, operative treatment is contra-indicated.

When there is severe 'concussion,' a condition usually indicating brain-laceration, considerable doubt exists with regard to the advisability of urging operative interference. In general, it may be stated that a persistent subnormal temperature implies such severe intracranial injury, and so severe a state of shock, that operation is most unlikely to improve the patient's condition. On the other hand, when the temperature rises progressively, it may be accepted that the patient is passing from the state of shock to that of reaction, from the stage of concussion to that of compression, that hæmorrhage is taking place within the skull, and that operation is called for.

When there is 'irritation,' a condition usually implying cerebral contusion or slight cerebral laceration, operation is again contra-indicated. 'Irritation,' as here alluded to, implies general cerebral irritation, and not that localized trouble which arises from the pressure of depressed fragments of bone, &c.

When there is 'compression,' a condition usually associated with depressed fragments of bone or intracranial hæmorrhage, operative measures are urgently called for.

[1] *Boston City Hospital Reports,* 1894.

The advisability of operating on fractures that only involve the internal table of the skull. The diagnosis of a fracture limited to the internal table is only possible when symptoms of localized irritation ensue, due either to the direct pressure exercised by the depressed fragments of bone on the dura mater or brain, or to the irritation resulting from a torn meningeal artery. In such cases, operation is indicated. Otherwise, no early diagnosis is possible, and the surgeon must adopt an expectant attitude, awaiting the onset of symptoms and seizing the earliest opportunity to remedy the condition.

Operation. *Preliminary measures.* If there should be a wound of the scalp, no attempt should be made to gauge the extent of the injury till the region of the wound has been shaved and cleansed: digital examination enables one to obtain far more certain information as to the extent of the injury than can be obtained by any instrumental means. It is perhaps hardly necessary to add that care must be taken to avoid mistaking one of the sutures of the skull for a fissured fracture.

Exploration having been determined upon, and the usual preparatory treatment carried out, the scalp-tourniquet is applied, and a suitable scalp-flap framed and turned down, advantage being taken in the formation of the flap of any existent scalp injury.

The subsequent details vary according to the nature of the fracture.

Fissured fractures. If, after thorough exposure of the parts, the operator be satisfied that he has to deal with an uncomplicated fissured fracture, the scalp-flap is returned into position, and a small drainage tube inserted at the most dependent part of the flap, this tube being allowed to remain for twenty-four to thirty-six hours.

If, on the other hand, the symptoms point to the presence of an extra-dural hæmorrhage, the bone is trephined where the line of fracture crosses the course of the suspected vessel. In subdural extravasation the trephine is applied over that part of the brain, in the immediate vicinity of the fracture, from which the symptoms appear to emanate.

In a small proportion of cases, the symptoms point to a marked increase in the intracranial pressure without any definite localizing features. Under such circumstances, much can be done to relieve the increased pressure by carrying out the operation of 'cerebral decompression' (see p. 392).

Depressed fractures. The operative details vary according to the nature of the osseous lesion.

(*a*) If the depressed fragments of bone are interlocked in such a manner that simple elevation is impossible (*e.g.* pond and gutter fractures), it will become necessary to trephine in the immediate vicinity of the fracture in order to lessen the mutual attachment of the fragments

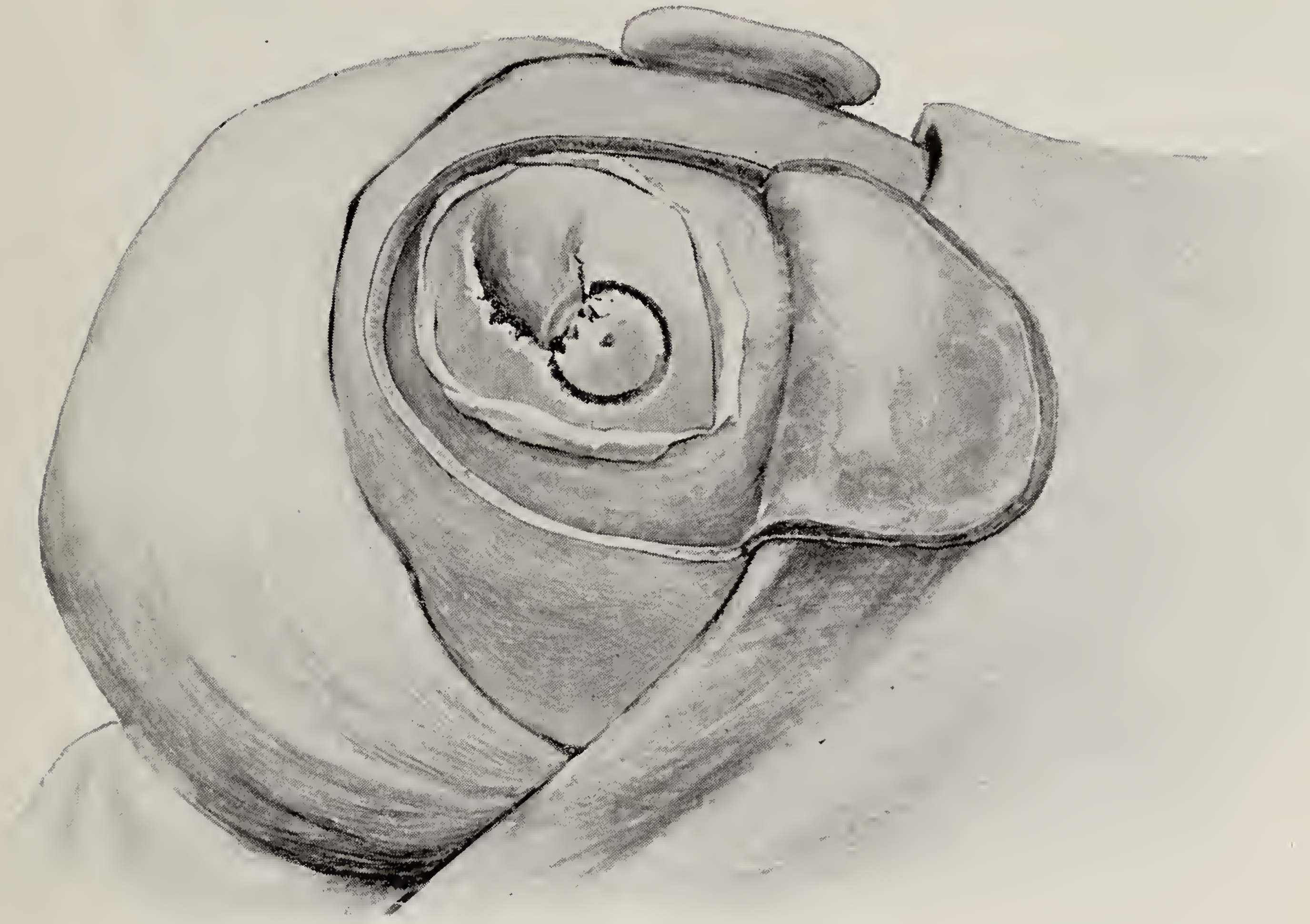

FIG. 211. THE ELEVATION OF A DEPRESSED FRACTURE. *First stage.* The trephine circle includes the outer portion of the depressed area.

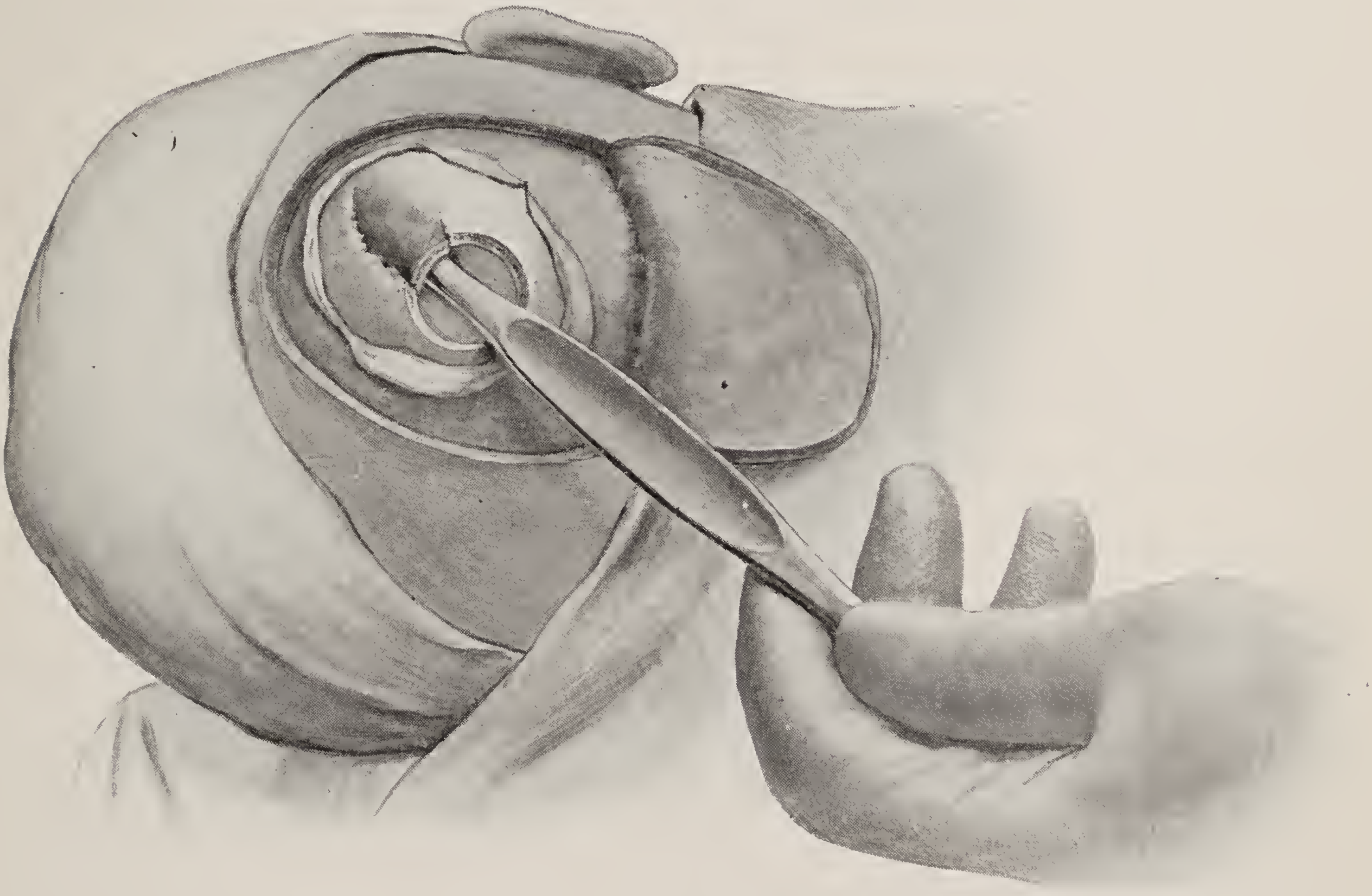

FIG. 212. THE ELEVATION OF A DEPRESSED FRACTURE. *Second stage.* The trephine disk has been removed and the elevator is in position.

one to another, and obtain sufficient purchase for their elevation or removal.

The pericranium is stripped away from the region of the depression (see Fig. 211), and a small trephine applied in such a manner that the trephine circle includes the outer part of the depression. Care must be taken to avoid more pressure than is absolutely necessary over the depressed fragments for fear of causing injury to the underlying soft parts. This advice is all the more necessary when it is realized that the fracture of the internal table is almost invariably more extensive than that which involves the external table of the skull.

The disk of bone is removed and the conditions investigated with the dural separator. When the degree of depression and the splintering of the internal table are not excessive, the parts may be elevated into position. In most cases, however, the uncertainty that exists with regard to the possibility of extensive splintering of the internal table, with dural laceration or other lesion, renders it necessary that the depressed fragments should be either elevated and removed, or elevated to such an extent that the dura can be fully investigated. For this purpose, the craniectomy forceps may be needed. The dura can be now examined. If torn, the opening may require enlargement in order that the brain can be brought into view in such a manner that complete investigation can be carried out for any osseous fragments that may have been driven into it; all such fragments are carefully removed. All hæmorrhage is arrested, the dura mater sewn up, and the scalp-flap approximated, a rubber drainage tube being inserted at the most convenient part.

(*b*) When the depression is of such a nature that the elevation of the fragments can be carried out without preliminary trephining, the fragments are raised with the periosteal elevator, and the membranes and brain examined as described above.

Before turning to the next class of fracture, it will be convenient to allude briefly to the modern teaching with regard to the replacement of osseous fragments and trephine disk.

In simple fractures, the disk and larger fragments of loose bone are to be replaced in the anticipation that they will live entire, in part, or will act as a scaffolding medium for the formation of dense fibrous tissue. After removal from the wound, and during the completion of the operation, the vitality of all loose fragments may be preserved by placing them in hot saline solution.

In compound fractures, the smaller fragments are discarded, whilst the trephine disk and larger fragments of bone may be boiled and then replaced. It must, however, be clearly understood that all replaced fragments of bone act as sequestra unless primary union of the wound can be assured. The question of replacement depends, therefore, to a large extent on the nature of the wound. In all septic cases it is necessary to discard all loose fragments, merely preserving those that retain their pericranial attachment. The gap in the vault may be remedied at a later date by one or other of the methods advocated for the closure or protection of defects in the skull (see p. 411).

Punctured fractures. In this class of fracture there is a special liability to dural laceration and in-driving of comminuted fragments of bone. A full exposure of the parts is therefore essential. The trephine can be applied in the immediate vicinity of the fracture, or, as is often preferable, the site of puncture may be enclosed in the circle resulting from the use of a large-sized trephine. After removal of the bone, the craniectomy forceps may be required to afford complete exposure of the dura mater. The site of dural puncture is enlarged with the blunt-pointed scissors, the brain examined, and all loose particles of bone removed. The dura should be sewn up as well as circumstances permit, and the wound drained as alluded to in the previous section.

Fractures limited to the external table. Fractures limited to the external table usually result from the impact of glancing bullets, and, in the absence of symptoms pointing to the existence of intracranial complications, it is merely necessary that a suitable scalp-flap should be framed, turned down, and all comminuted fragments of bone, dirt, and foreign bodies removed. The 'gutter' in the bone is examined, the ragged edges repaired with a gouge or Volkmann's spoon, and the wound lightly plugged and drained.

Fractures limited to the internal table. As previously indicated, the diagnosis of this condition is only practicable when the depression of osseous fragments, &c., so irritate the dura mater and brain that localizing symptoms ensue. For instance, epileptic fits of a Jacksonian type may develop shortly after the accident, this condition demanding a full exposure of the affected region. The operations necessary for the treatment of traumatic epilepsy and insanity are dealt with in Chapter V.

OPERATIONS FOR FRACTURE OF THE BASE OF THE SKULL

Indications. Fracture of the base of the skull is not fatal in itself, death occurring from one or other of the intracranial complications incident to the fracture—hæmorrhage, brain laceration, &c. The operative treatment of fracture of the base of the skull comprises, therefore, those measures indicated for the relief of the particular compli-

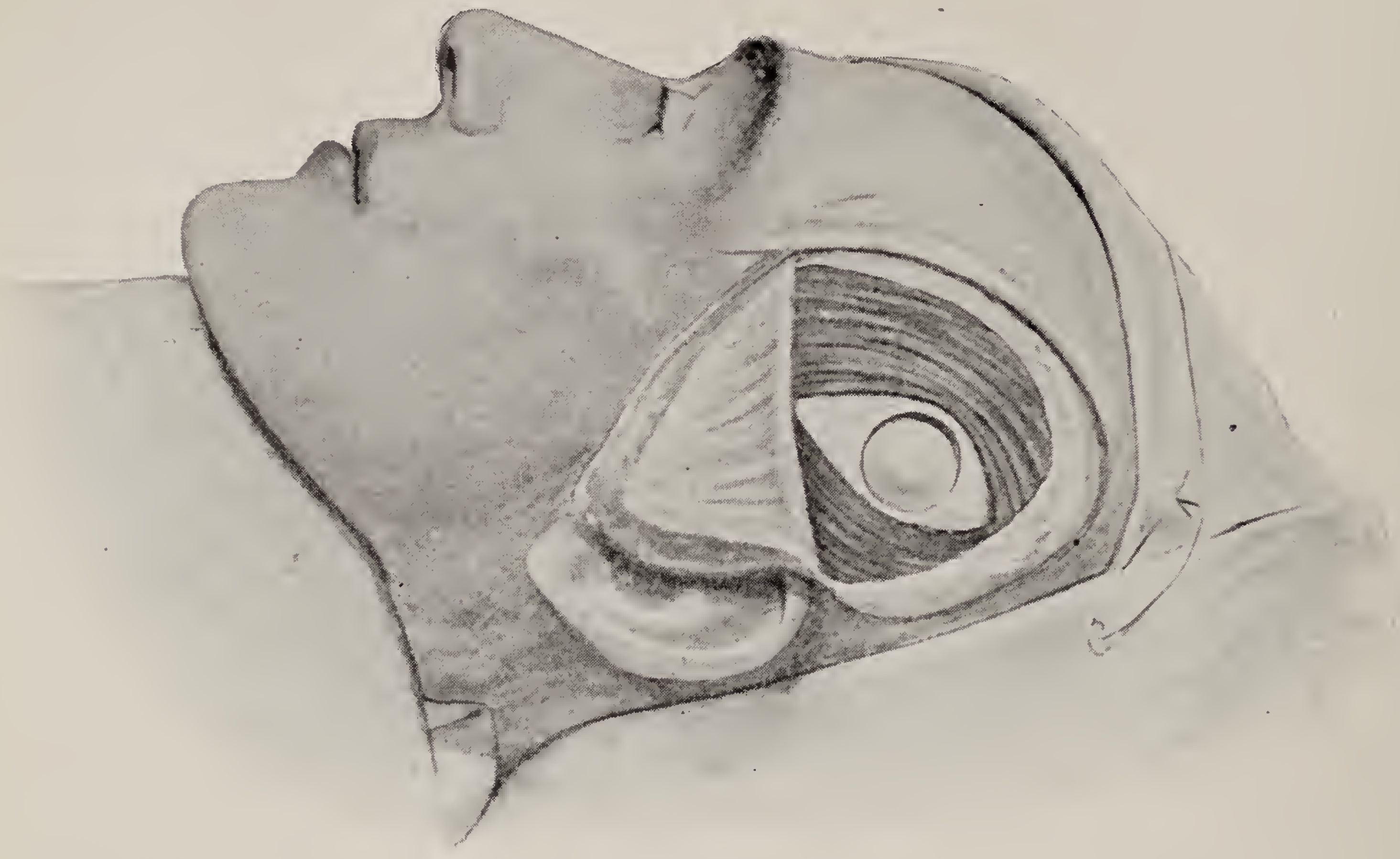

FIG. 213. THE 'INTERMUSCULO-TEMPORAL OPERATION' OF CUSHING. *First stage.* The skin and temporal fascia have been turned down as separate flaps, and the temporal muscle has been split in the direction of its fibres. The exposed bone has been trephined.

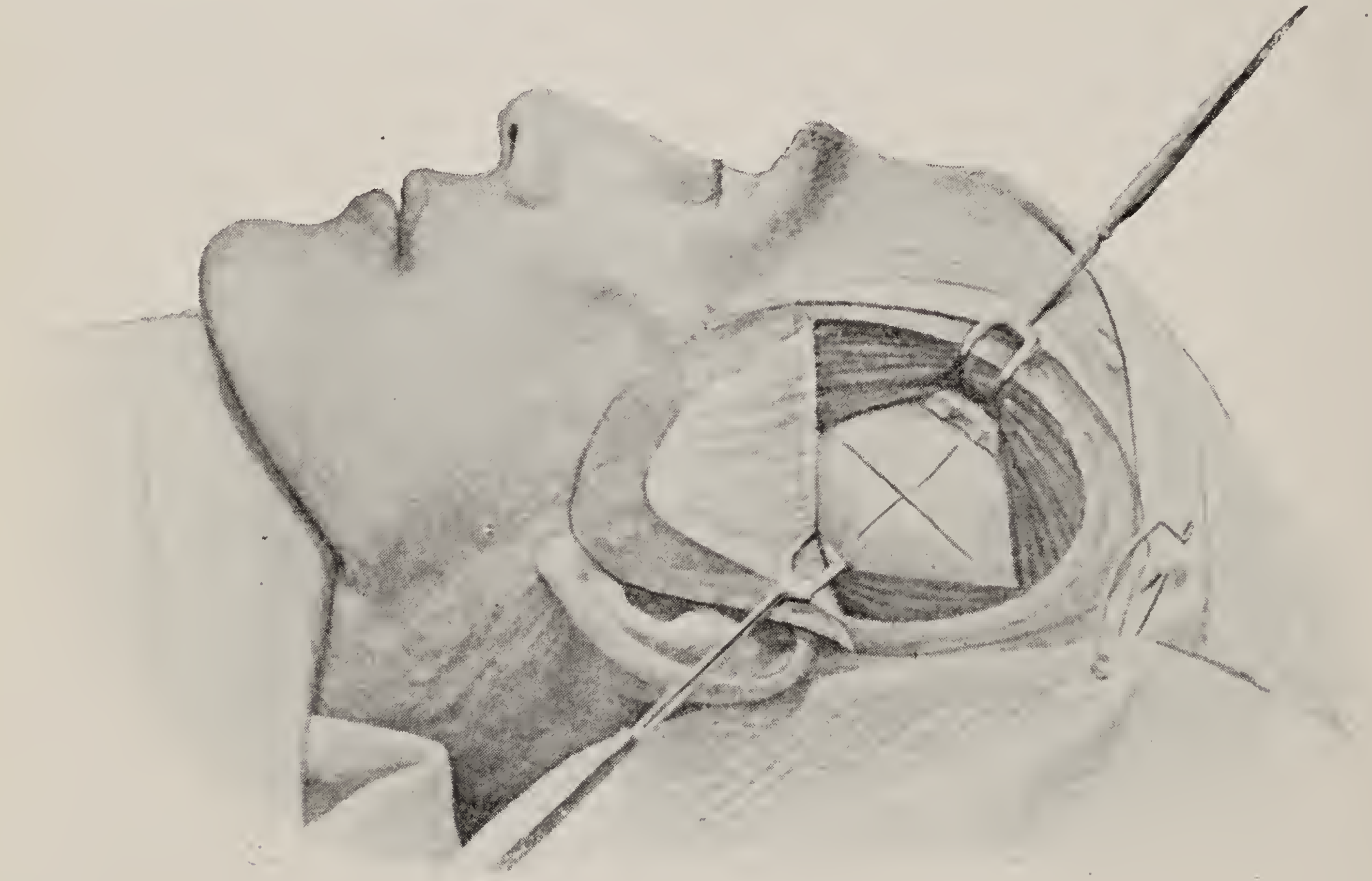

FIG. 214. THE 'INTERMUSCULO-TEMPORAL OPERATION' OF CUSHING. *Second stage.* The fibres of the temporal muscle are widely retracted, and the underlying bone has been freely removed. The bulging dura mater is incised crucially.

cation present. For each and all of these reference must be made to other sections.

In the absence of all localizing features, benefit may often be derived by the adoption of those operative procedures that aim at the reduction of an increased intracranial pressure ('decompression' operations). Such 'decompression' operations are urgently called for when the raised temperature, slow full pulse, stertorous respiration, and flaccid extremities point to a condition of brain-compression.

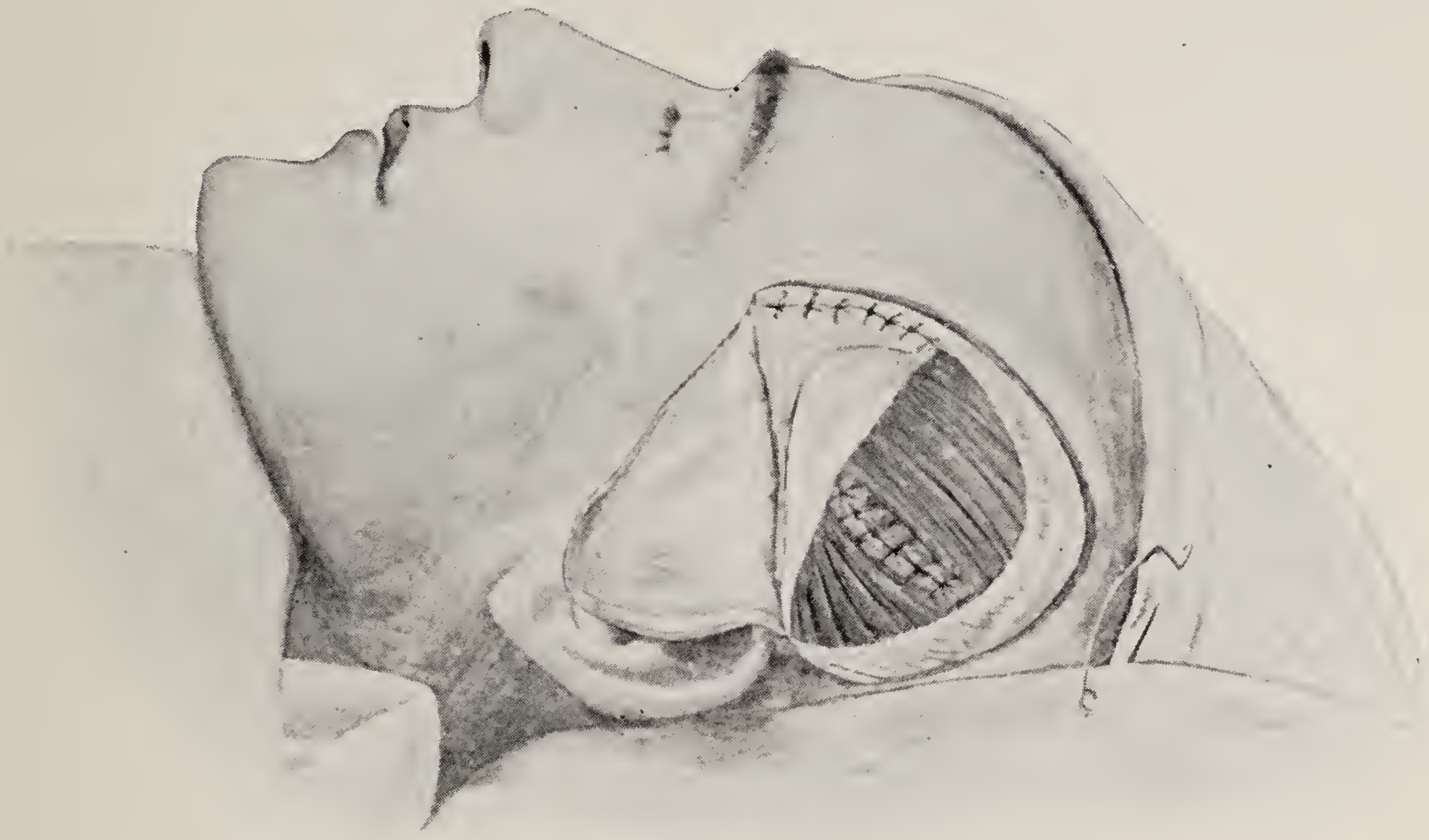

FIG. 215. THE 'INTERMUSCULO-TEMPORAL OPERATION' OF CUSHING. *Third stage.* The split temporal muscle is reunited and the temporal fascia is partly sewn into position. Note the fringe of temporal fascia attached to the upper temporal crest.

'Decompression' operations may be carried out either in the cerebellar region or over the temporo-sphenoidal lobe, one of the so-called 'silent areas' of the brain. The operations are known as 'cerebellar' and 'temporal decompression' respectively.

The writer has had considerable experience of both operations, and though, theoretically, the cerebellar operation should bring about the greatest benefit to the patient, insomuch as the exposure is carried out in the immediate neighbourhood of the medullary centres, and though the immediate results of the operation may be satisfactory, yet the fact remains that but very few lives are saved by adopting such measures.

On the other hand, the disadvantages of the operation described by

Harvey Cushing as 'intermusculo-temporal cerebral decompression' are very great. They have been summarized by Cushing as follows:—

(*a*) The frequency with which the bony lesion occurs in the middle fossa of the skull.

(*b*) The fact that cerebral contusions are especially liable to involve the tip of the temporo-sphenoidal lobe.

(*c*) The exposure of the territory of the middle meningeal artery, and the ease of determining the presence of an extra-dural hæmorrhage.

(*d*) The possibility of draining through a split muscle rather than through the scalp.

(*e*) The subsequent protective action of the muscle in case a hernia tends to form in consequence of traumatic œdema.

(*f*) The subsequent absence of deformity, the skin incision being carried out in the main through the hairy portion of the scalp.

Operation (the intermusculo-temporal operation of Cushing). After the application of the scalp-tourniquet, an incision is made which starts immediately posterior to and below the external angular frontal process, and passes upwards and backwards along the line of the temporal crest to curve down finally to a point just above the ear. The incision involves the skin and subcutaneous tissues only, and the flap, including the superficial temporal vessels, is turned down to its base. Great care must be taken to avoid cutting the temporal artery at the base of the flap. The exposed temporal fascia and muscle are then divided down to the bone by an incision which corresponds in direction to the line of the temporal muscle fibres, and which passes obliquely downwards and forwards, from the central point of the temporal crest to the mid-point of the zygoma. In the region immediately above the zygoma, this division of muscle fibres is carried out preferably by forcible retraction. Troublesome hæmorrhage is thereby often prevented. All bleeding points are secured. The muscle fibres are then stripped, both forwards and backwards, from the bones entering into the formation of the temporal fossa, care being taken to avoid detachment of the muscle from the temporal crest itself. The pin of the trephine is placed over the angle between the anterior and posterior branches of the middle meningeal artery, and the disk of bone removed. The dura is separated from the overlying bone, the craniectomy forceps applied, and the bone entering into the formation of the temporal fossa freely cut away. The removal of bone should be carried out mainly in the anterior and posterior directions. The bulging dura is incised crucially, right up to the margins of the osseous gap, all meningeal vessels that cross the line of dural section being previously ligatured on either side of the proposed line of dural section. The anterior part of the temporo-sphenoidal lobe is exposed, and, by gentle retraction, a small rubber drainage tube may be inserted along the floor of the middle fossa of the skull.

The drainage tube is brought out through the dura (which membrane is not sewn up) and through the split fibres of the temporal muscle, these being otherwise carefully approximated. The scalp-flap is sewn into position with silk or salmon-gut sutures, a hole being cut for the exit of the tube. Drainage should be maintained for at least twenty-four hours, and longer, if necessary.

As a slight modification of Cushing's operation, the writer has found that certain advantages can be obtained if the temporal fascia be turned down as a separate flap, a fringe being carefully retained along the temporal crest to aid in the later approximation of the fascia. If this proceeding be carried out, a greater area of bone can be removed, a matter of considerable importance when it is considered that the relief of intracranial pressure is directly proportional to the size of the gap in the skull and the extent of the dural incision.

After the union of the temporal muscle, the fascia is united, if possible, to the fringe that has been preserved in the region of the temporal crest. This modification is depicted in Figs. 213–215.

OPERATIONS FOR FRACTURE OF THE VAULT AND BASE OF THE SKULL IN CHILDREN

Indications. The marvellous vitality and recuperative power of the infant justify the surgeon in adopting a more expectant policy than that indicated for similar conditions in adults. Otherwise, the indications for operation closely resemble those previously alluded to in dealing with fractures of the skull in adults.

Birth-fractures. Under this heading are included those fractures which result from birth-injury and those also which occur shortly after birth, from whatsoever cause.

Both fissured and depressed fractures are seen, and are alike usually more or less obscured by the presence of an overlying hæmatoma.

Simple uncomplicated fissured fractures require no surgical interference, but when the fracture is associated with symptoms indicative of intracranial hæmorrhage, the ordinary treatment, as laid down in the preceding sections, must be carried out. Babies are also liable to a special variety of subdural extravasation, a condition known as 'birth-hæmorrhage,' to which allusion is made on p. 404.

With regard to depressed fractures, much difference of opinion exists as to the requisite treatment. Some surgeons maintain that the depression will rectify itself in the course of time, whilst others urge that evidence is gradually accumulating that such favourable results are rather the exception than the rule, and that the depression usually persists as a permanent defect, retarding the development of the underlying cortical substance.

In the absence of symptoms pointing either to general or local irritation the depression may be allowed two weeks in which to rectify itself, and failing any improvement in the local conditions the surgeon must consider the advisability of remedying the defect.

The operative treatment of depressed fractures. After every precaution has been taken to lessen the shock which will accompany and follow the operation, a scalp-flap is turned down which will suffice to expose the depressed area of bone. The trephine (½ inch diameter) is then applied in such a manner that the trephine circle includes the outermost margin of the depressed region. After removal of the disk, the dura mater is gently separated from the under aspect of the bone and the depressed region elevated outwards with the aid of the periosteal elevator, the apex of the instrument being applied to the apex of the depression. The bone usually springs back readily, and in such cases the trephine disk can be replaced and the wound sewn up.

In some cases, however, the defect cannot be remedied in this manner, the depression recurring as soon as the outward leverage is removed. It has therefore been recommended that the depressed region should be completely cut out with a large trephine, inverted on a swab or sterilized towel, reduced to the required curvature, and then replaced in such a position that the internal surface finally becomes external.

Nicholl[1] reports twenty-three cases in which operation was carried out for depressed birth-fractures with the following results:—

(*a*) In ten cases the depression was merely levered back into position. All these cases ultimately gave disappointing results on account of recurrence of the deformity.

(*b*) In thirteen cases trephining and inversion were carried out. In all these the ultimate result was most satisfactory, osseous union being apparent after ten days.

Gunshot Wounds of Head. The extensive experience of war surgeons in this phase of traumatic surgery has been considered by Penhallow in Vol. V of this system.

[1] *Annals of Surgery,* December, 1904.

CHAPTER IV

OPERATIONS FOR INTRACRANIAL HÆMORRHAGE

OPERATIONS FOR HÆMORRHAGE FROM THE MIDDLE MENINGEAL ARTERY

Indications. Operative interference is indicated in all cases of hæmorrhage from the middle meningeal artery if the condition of the patient be compatible with such treatment. The earlier the operation is carried out the better.

Operation. For hæmorrhage from the anterior branch. After the usual preparatory treatment, the 'site of election' for trephining is marked out on the scalp by taking a point which lies 2 inches posterior to the external angular frontal process and the same distance above the zygoma. A bradawl is introduced through the scalp so as to indent the external table of the skull, thus aiding in the subsequent application of the trephine. This procedure cannot be carried out if the hæmorrhage be associated with a depressed or comminuted fracture in the temporal region. Under these circumstances the affected region is exposed merely by the formation of a suitable scalp-flap.

An incision is made which starts immediately posterior to the external angular frontal process, curves upwards and backwards along the temporal crest, and terminates above the ear. The flap, comprising skin, temporal fascia, and muscle, is turned down to its base, and all bleeding points secured. The scalp-tourniquet is seldom applicable to this condition, and consequently the hæmorrhage is often profuse.

The subsequent procedures vary according to the condition of the bone.

If there be no fracture of the temporal region, the pin of the trephine is placed over the indented spot and the disk of bone removed. Although the presence of an extra-dural clot would minimize the danger of dural injury, yet the trephining must be carried out with all the usual precautions. In the event of an error in diagnosis the surgeon merely adds further complication to the case if either middle meningeal artery or dura be injured, valuable time being lost in the rectification of the trouble.

After the removal of the disk of bone the clot will be exposed, but, in order to obtain more ample exposure, the gap must be enlarged with the craniectomy forceps, this enlargement being carried out in a direction corresponding to the general course of the vessel, that is, upwards and downwards (see Figs. 216, 217).

If a fissured fracture be found, the bone is trephined where the fracture crosses the line of the artery.

When the fracture is comminuted, the fragments of bone are either levered outwards or removed till sufficient room has been obtained.

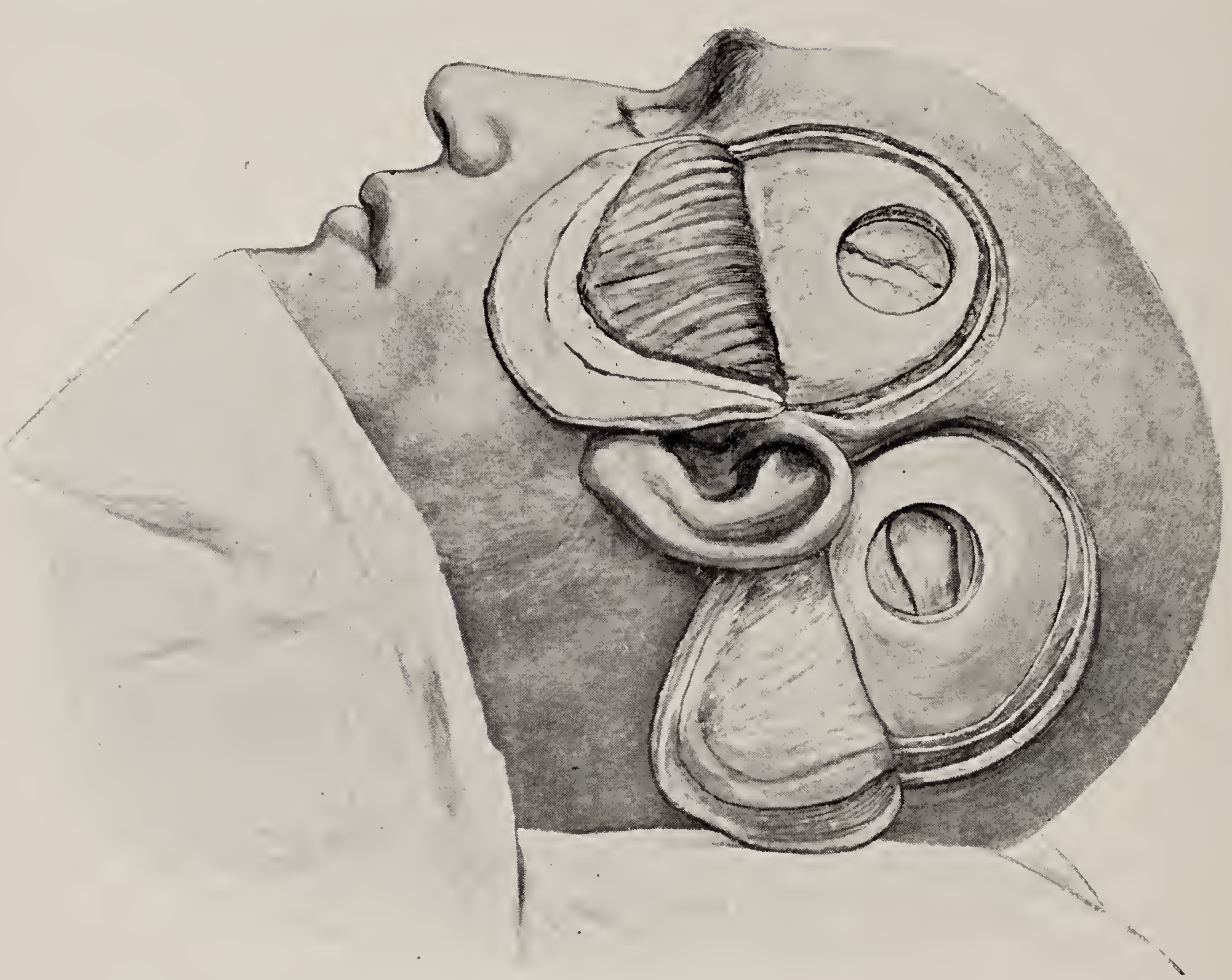

Fig. 216. Exposure of the Branches of the Middle Meningeal Artery. *First stage.* Suitable scalp-flaps have been turned down, and the skull has been trephined over the 'sites of election' for exposure of both anterior and posterior branches.

The greater part of the clot can be removed either with a Volkmann's spoon or ordinary teaspoon, aided by free irrigation with hot saline solution.

Bleeding points should either be seized with forceps and tied with fine catgut, or underrun, with a fully-curved needle threaded with catgut, on either side of the actual site of arterial laceration. The needle must be passed so as to avoid injury to the pia-arachnoid, and, as the vessel is embedded merely in the outer wall of the dura mater, it is not even necessary that the whole thickness of the dura should be penetrated with the needle.

When the artery is injured above the level of the gap in the skull, the bone is nibbled away in the upward direction till the bleeding point is exposed. Hæmorrhage is then controlled in the manner described above.

When the blood wells up from below, the craniectomy forceps are again called into requisition, and the bone cut away rapidly towards the base of the skull. In the more serious cases, it may be necessary to remove the greater portion of the bone entering into the formation of the temporal fossa. In the meantime, the bleeding may be controlled by plugging towards the base of the skull with narrow strips of gauze. Sufficient bone having been removed, the gauze is withdrawn, when smart sponging should enable the operator to determine the source of the hæmorrhage. At this stage of the operation a head-lamp will be found useful. After the exposure of the bleeding point, the following measures can be adopted whereby to arrest the hæmorrhage:—

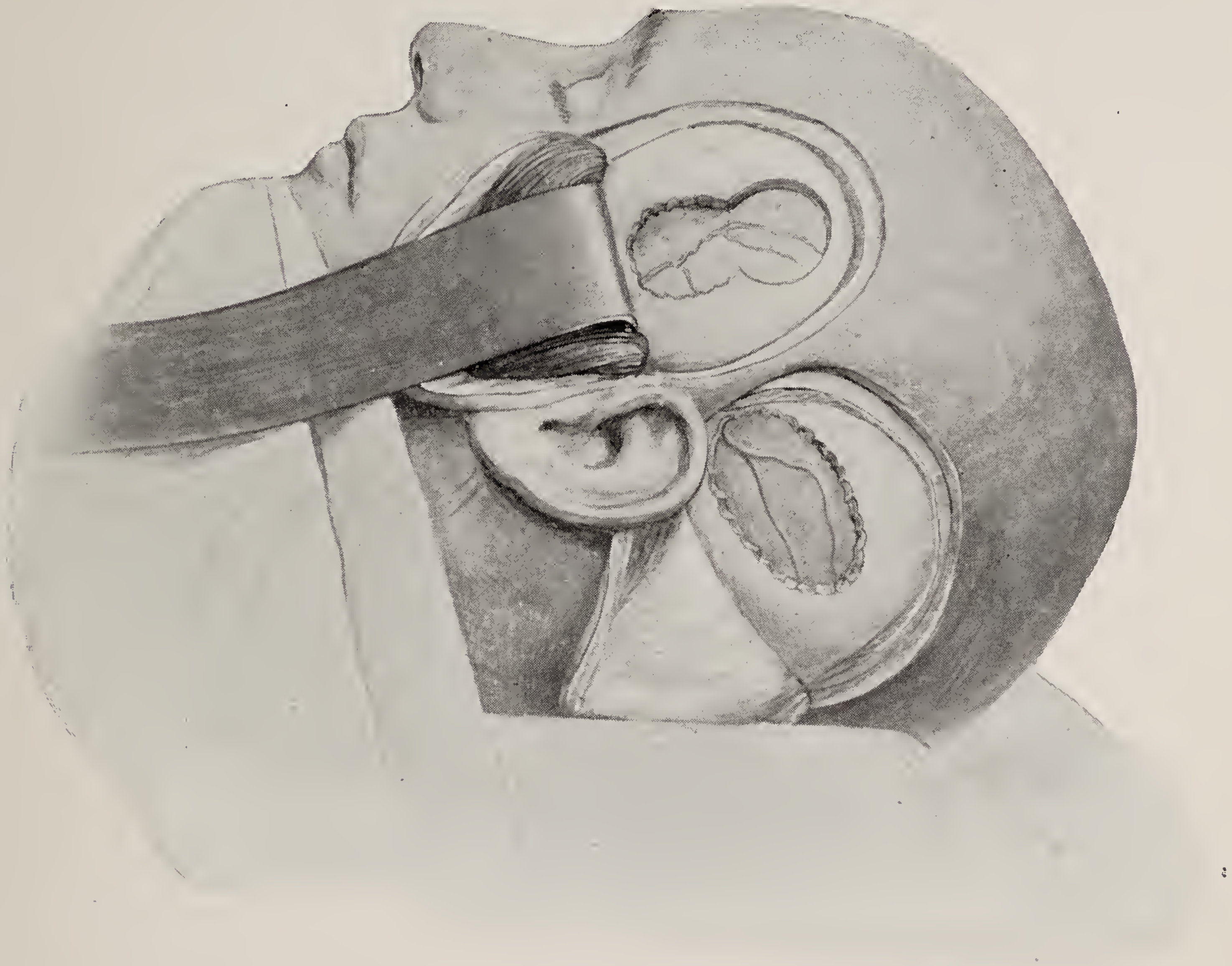

FIG. 217. EXPOSURE OF THE BRANCHES OF THE MIDDLE MENINGEAL ARTERY. *Second stage.* The trephine holes have been enlarged with the craniectomy forceps in the required directions.

(*a*) The application of a ligature on either side of the site of arterial injury.

(*b*) The vessel may be underrun on either side of the injured part.

(*c*) The vessel may be seized with artery forceps and twisted.

(*d*) The hæmorrhage may be arrested by means of gauze plugging.

(*e*) The foramen spinosum may be occluded.

(*f*) The common or external carotid arteries may be ligatured.

Every effort should be made to control the hæmorrhage by ligature, underrunning, or torsion. Such measures are often difficult to accomplish and the surgeon must then have recourse to one of the other methods applicable to the case. Gauze plugs can be relied upon usually to stop the bleeding, but they possess one great disadvantage—they exercise pressure on the cortex and prevent expansion of the brain. The occlusion of the foramen spinosum and the ligature of the common or external carotid arteries complicate and prolong the operation.

The foramen spinosum is exposed in the following manner: The dura mater is rapidly stripped up from the base of the skull, the soft parts gently but firmly retracted, and the foramen identified. Its occlusion may then be effected either by means of a sterilized wooden match, by a small piece of bone derived from those osseous fragments which have been removed during the enlargement of the trephine hole, or by a stout piece of catgut well driven into the hole.

It is open to doubt whether ligature of the common or external carotid arteries is ever necessary, though several cases have been recorded in which such a course was adopted. The external carotid should be tied in preference to the common vessel, since, the brain being already compressed, further interference with the blood-supply will necessarily increase the risk of cerebral œdema and softening.

The hæmorrhage having been arrested, the cavity is thoroughly flushed out with hot water and drained. A small rubber drainage tube will often suffice, though, in the more serious cases and especially when the hæmorrhage has been arrested by means of gauze tampons, the cavity should be plugged lightly with gauze. The proximal ends of the gauze strips are brought out through the most convenient part of the scalp-flap. These drains are allowed to remain for twenty-four to thirty-six hours, at the end of which time they may be shortened or removed according to the circumstances of the case.

Alternative measure for the exposure of the anterior branch of the middle meningeal artery. By some surgeons it is advocated that the artery should be exposed by the formation of an osteoplastic flap (see p. 375). The disadvantages of such a method may be classified as follows:—

(*a*) Rapidity of operation is essential, both for the relief of pressure and for the control of the bleeding. Valuable time is lost in the formation of the flap.

(*b*) The bleeding is usually associated with a fissured or comminuted fracture of the bones of the temporal fossa; under such circumstances the flap cannot be formed.

(*c*) An osteoplastic flap restricts the operative field, this being especially the case when the source of the hæmorrhage is situated low down in the middle fossa of the skull.

(*d*) An incorrect diagnosis as to the site of the hæmorrhage may be made, thus necessitating the further enlargement of the gap in the skull, and possibly the removal of the entire bone-flap.

By other surgeons, it has been recommended that the clot should be exposed by means of the intermusculo-temporal operation of Cushing (see Fig. 213). This course is ideal, but unfortunately, from the limitation of the operative field, seldom practicable. The exposure of the clot may, however, be carried out through the fibres of the temporal muscle when the injury has been inflicted below the level of the temporal crest, when the clot is small in extent, and when the case is seen shortly after the accident.

For hæmorrhage from the posterior branch. The 'site of election' for exposure of the posterior branch of the middle meningeal artery corresponds to the point of intersection of the two following lines:—

(1) A line drawn backwards from the upper border of the orbit parallel to Reid's base-line (see p. 359).

(2) A line drawn vertically upwards from the posterior border of the mastoid process of the temporal bone.

The skull is trephined at this point, and the gap in the skull enlarged with the craniectomy forceps in the forward and backward directions (see Fig. 217). The bleeding is arrested after the methods enumerated in the section dealing with hæmorrhage from the anterior branch of the artery.

Results. The ultimate result of operation for middle meningeal hæmorrhage depends on two factors—the time at which the operation is carried out, and the presence or absence of brain contusion and laceration. There is every reason to believe that, when treated early and when unassociated with brain injury, the prognosis, both immediate and remote, is entirely satisfactory.

Wiesman[1] collected 257 cases, of which 110 were submitted to operation, with a mortality of 27%. Of the cases in which no operation was performed 88% died.

[1] *V. Bergmann's System of Surgery*, vol. i.

Duchaîne[1] reports 27 cases in which operation was carried out, with death in 6 cases only, a mortality of 22%. No operation was carried out in 7 cases, and all but one died.

Von Bergmann[2] collected 110 cases treated by operation, with 74 recoveries and 36 deaths, a mortality of 32.27%.

These statistics are most instructive, pointing to the urgent necessity of early operation in every suitable case.

OPERATIONS FOR HÆMORRHAGE FROM THE SUPERIOR LONGITUDINAL SINUS

Wounds of the superior longitudinal sinus are almost invariably associated with comminution and depression of the overlying vault, the sinus-wall being perforated, perhaps transfixed, by one or more of the osseous fragments. The blood tends to escape externally along the line of least resistance, but, in the event of interlocking of fragments, or as the result of application of firm pressure, hæmorrhage takes place into both extra-dural and subdural spaces. Extra-dural extravasation is seldom excessive on account of the adherence of the dura to the bone and the low venous pressure. The subdural space, on the other hand, permits of extensive hæmorrhage, on one or both sides of the falx cerebri. The operative measures may therefore be considered under two headings:

(*a*) For injury to the parietal wall with external hæmorrhage.

(*b*) For injury to the visceral wall with subdural hæmorrhage.

Operations for injury to the parietal wall with external hæmorrhage. After the application of the scalp-tourniquet, a flap is turned down, comprising the whole thickness of the scalp and so framed as to receive the best possible blood-supply. Advantage should be taken of any existent scalp injury.

The fracture being in this manner fully exposed, all depressed fragments of bone (excepting such as appear to be embedded in the sinus-wall, which for the time being are allowed to remain) are elevated and removed. Complete exposure of the sinus is required, both in front and behind the actual site of injury, for which purpose the craniectomy forceps should be utilized. If the hæmorrhage be copious it may be arrested by the insertion of strips of gauze between the bone and the dura, in such a way as to obliterate the lumen of the sinus. When all bleeding is controlled, any fragments of bone that project into the sinus may be withdrawn. The rent in the wall should be treated after one of the following methods:—

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[1] *Ruptures de l'artère méningée moyenne,* Paris, 1890.

[2] *System of Surgery,* vol. i.

(*a*) It may be possible to sew up the rent with fine catgut. If feasible, this method should always be adopted.

(*b*) The dura may be drawn across from side to side by means of two or three Lembert's sutures introduced in the following manner: A small fully-curved needle, threaded with catgut, is passed through the dura immediately to one side of the sinus, drawn across the site of laceration, and again passed through the dura on the opposite side. The sutures do not penetrate the sinus-wall, and, when tightened up, the lumen of the sinus is practically obliterated. Lateral incisions through the dura, for relief of tension, may be required.

(*c*) The sinus may be ligatured in the following manner: Incisions, ½ inch long, are made through the dura mater, parallel to the line of the sinus and on either side of the rent in the vessel-wall. An aneurysm needle is passed through the falx cerebri and around the sinus, entering and emerging at the dural incisions. The needle is threaded with catgut and withdrawn. Ligatures can be applied in this manner both in front of and behind the site of sinus laceration.

(*d*) In the event of failure to arrest the hæmorrhage by any of the methods mentioned above, the hæmorrhage can be controlled by the insertion of gauze plugs between the bone and the sinus. These plugs should be allowed to remain for twenty-four to thirty-six hours, after which time the wound should be lightly repacked.

Operation for injury to the visceral wall with subdural extravasation. It is usually impossible to remove all the subdural clot, but much can be done to remedy the condition. The dural tension, the absence of pulsation, and the peculiar plum-colour transmitted to the dura by subdural hæmorrhage, not only point to the nature of the trouble, but also enable the surgeon to determine on which side of the falx cerebri the hæmorrhage is situated.

Free drainage must be established, and it is necessary, therefore, that a counter-incision should be made through the dura at the most dependent point possible. A suitable region may present if the bone be extensively comminuted. Otherwise, a narrow channel must be cut in the bone with the craniectomy forceps, prolonged in the downward direction till the lower limit of the clot is reached (see Fig. 218). In carrying out this procedure, it may become necessary to extend the scalp incision.

The presenting clot is then removed, partly with the spoon and partly by irrigation. Irrigation may be carried out with advantage from the site of primary dural injury to the counter-incision below.

In the more favourable cases, both dural incisions may be closed up, but in the majority of cases it is advisable to establish drainage, a rubber drainage tube being inserted in the manner shown in Fig. 219.

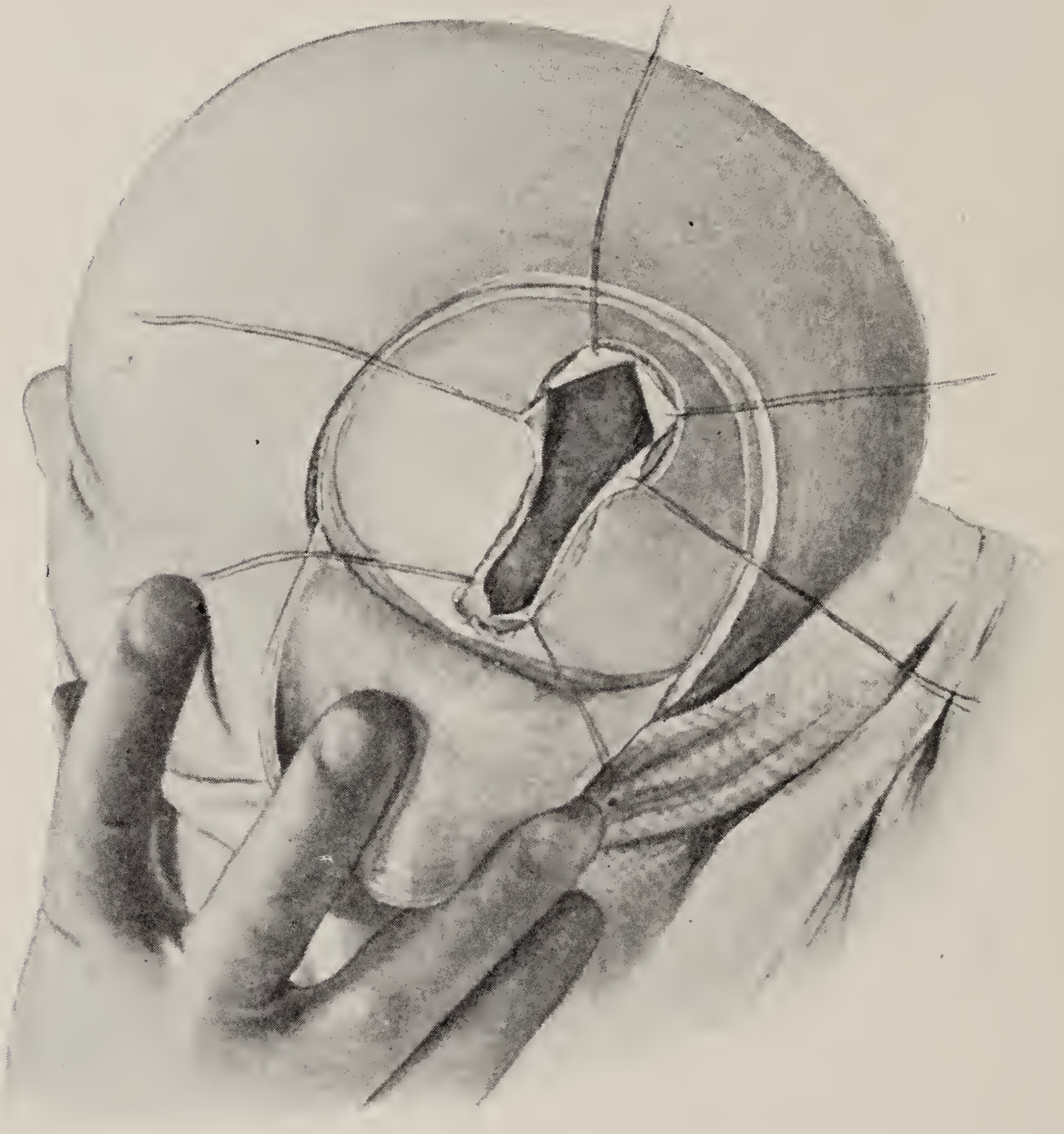

Fig. 218. The Operative Treatment of Subdural Hæmorrhage. *First stage.* The skull has been trephined over the upper part of the clot and the bone cut away in the downward direction in order to reach the lower limits thereof. The dura mater has been incised, crucially in the upper part and vertically in the lower part.

OPERATIONS FOR TRAUMATIC SUBDURAL HÆMATOMA OR HÆMATOCELE

It is probable that the hæmatoma forms a short time after the accident, but the symptoms resulting, both of general increase in intracranial pressure and of local brain compression, seldom become marked before ten days have elapsed from the time of the accident. Subdural hæmatoceles usually occur over that part of the brain which lies in relation to the fissure of Rolando. Definite localizing symptoms are consequently generally apparent.

The hæmatoma may be exposed either by craniectomy or craniotomy. The former operation is less dangerous to the patient and allows of sufficient exposure to remove the clot.

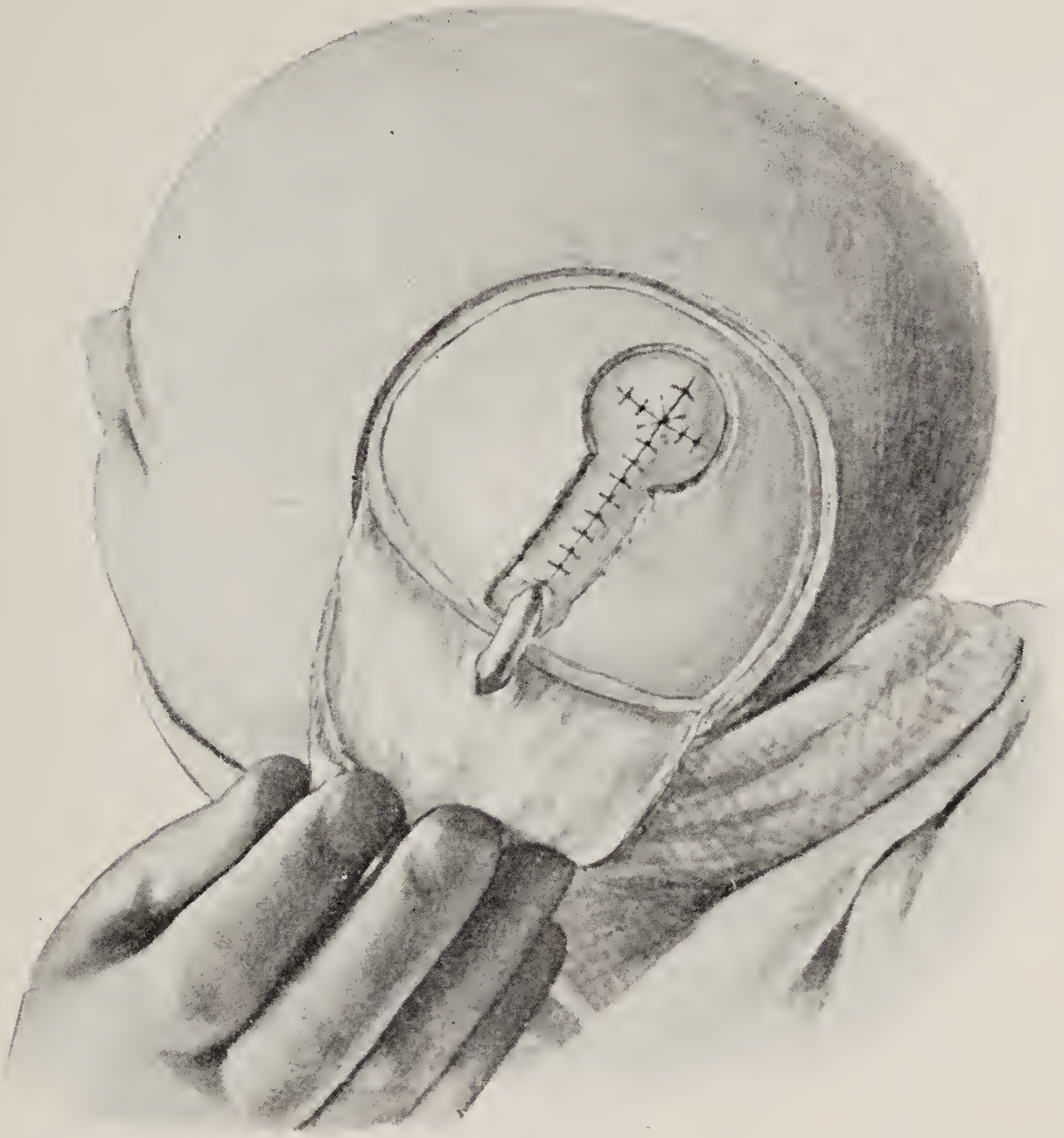

FIG. 219. THE OPERATIVE TREATMENT OF SUBDURAL HÆMORRHAGE. *Second stage.* The clot has been removed and the dura mater sewn up. A drainage tube has been inserted so as to drain the subdural region through the lower part of the scalp-flap.

Operation. The site of trephining having been determined, and the scalp-tourniquet applied; a bradawl is introduced through the scalp so as to indent the external table of the skull and allow of the subsequent accurate application of the trephine. A scalp-flap, suited to the occasion, is turned down, the skull trephined, and the disk of bone removed. The appearance of the dura mater enables the operator to verify the diagnosis. The bone is then nibbled away in the downward direction towards the lower limit of the clot, the scalp incision being prolonged in the same direction if necessary. In the region of the trephine hole the dura is incised in a crucial manner, and the four flaps held aside by means of catgut sutures passed through the apex of each flap. A blunt director is inserted beneath the dura, passed in the downward direction, and the membrane slit up to within a short distance of the lower margin of the osseous gap. Full retraction of the dura will allow the exposure of the clot. Its removal can be carried out by means of the scoop and by irrigation. The cut margins of the dura are approximated above by the cross union of the four apical sutures, and by the insertion of supplementary sutures applied where necessary. The downward prolongation of the dural incision is also sewn up, except at the most dependent point where a rubber drainage tube is inserted beneath the dura mater, and brought out through the scalp-flap (see Fig. 219). This tube must be allowed to remain for at least thirty-six hours.

Results. The most complete results of operative treatment for subdural hæmatoma are supplied by Bowen,[1] who, in a series of seventy-two cases, classifies the cases as follows:—

Class A. Subdural hæmorrhage, apparently without other serious brain injury.

36 cases. 22 recovered after operation.
14 died—11 without, and 3 after, operation.

Class B. Subdural hæmorrhage with serious brain injury.

36 cases. 6 recovered after operation.
30 died—10 without, and 20 after, operation.

In other words, every case died in which operation was not carried out, whilst, after operation, 28 recovered and 23 died.

OPERATIONS FOR PIAL AND ARACHNOID HÆMORRHAGE

The anatomical situation of the extravasated blood prohibits all attempt at direct removal. Much can be done, however, to relieve symptoms of 'compression.' For 'decompression' operations, reference should be made to the preceding chapter.

OPERATIONS FOR INTRACRANIAL HÆMORRHAGE IN THE NEW-BORN

The superficial cerebral veins, in their upward course towards the superior longitudinal venous sinus, occupy the fissures of the brain and are correspondingly protected from injury. In order, however, to enter the lateral lacunæ of the sinus the veins must necessarily leave their cerebral beds and enter upon a short but comparatively unprotected course, and, as a result of the overlapping of the parietal bones, it is in this part of their course that the vessels are liable to laceration. The resultant hæmorrhage is consequently subdural in position and takes place on one or on both sides of the falx cerebri. The clot varies in extent, but is more commonly situated immediately anterior to the fissure of Rolando, overlying that portion of the cortex which is responsible for the movements of the lower extremity of the opposite side. The symptoms of brain compression are associated consequently with symptoms of local irritation. The child may recover, but the effects on the underlying cortex are disastrous.

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[1] 'Traumatic Subdural Hæmorrhage,' *Guy's Hosp. Rep.*, vol. lix.

The age of the patient must not be allowed to weigh in the balance against operative interference, for, if due precautions are taken, the new-born child stands operation well. Cushing[1] also points out that 'the possibilities of surgical relief are limited to the first week or two after the hæmorrhage has occurred, for old cortical scars can neither be helped by medicine nor by the scalpel.'

The clot can be exposed by craniectomy or craniotomy. The latter operation results in a more complete exposure of the clot, but the shock is undoubtedly more severe.

Operation. Exposure by craniectomy is carried out in a manner similar to that previously described for 'traumatic subdural hæmatocele' (see p. 402). The operation should be carried out with the utmost expedition, and every precaution must be taken to avoid shock.

Exposure by craniotomy, advocated by Cushing, is carried out as follows: 'An omega-shaped incision just within the outer margin of the parietal bone is carried down to the bone through the scalp and pericranium, and the latter is scraped away so as to expose the thin serrated edge of the parietal bone. Under this a blunt dissector is passed, so that the edge of the bone is tilted up, and then, with a proper cutting instrument (strong blunt-pointed scissors suffice), the bone is incised in a line conforming with the skin incision 1 centimetre or more within the parietal margin. The parietal bone is then broken across at its base. The dura is opened by a curved incision some distance within the bony margin, and the superficial clot broken away and lifted off in fragments or irrigated away with a gentle stream of warm salt solution. The dura should be accurately sutured, the bone replaced, and the skin closed with suture.'

Results. Cushing reports nine cases with four recoveries, apparently complete and permanent. In the fatal cases there was an extensive extravasation over the entire hemisphere. In three cases a bilateral exposure was required.

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[1] *Keen's Surgery,* vol. iii, p. 99.

CHAPTER V

OPERATIONS FOR TRAUMATIC EPILEPSY AND INSANITY: CLOSURE OF DEFECTS IN THE SKULL

OPERATIONS FOR TRAUMATIC EPILEPSY, TRAUMATIC INSANITY, AND GENERAL PARALYSIS OF THE INSANE

A GREAT difference of opinion exists with regard to the amenability of cases of traumatic epilepsy, insanity, &c., to surgical treatment. Some surgeons urge operative treatment and report enthusiastically on their results, others express their opinions in the gloomiest possible terms. These divergent views are readily explained when it is considered that no absolute rules can be laid down as to the suitability of a case for operation, for the simple reason that no one can foretell with certainty the pathological conditions present. The symptoms may be due to the mere adherence of the scalp to the bone, to osteosclerosis, to depression of bone, matting of membranes, subdural hæmatocele or cyst, and to scarring of the brain. Some of these conditions are capable of cure, others of alleviation. The enthusiasts may have been exceptionally careful in their selection of cases or unusually lucky in the pathological conditions found at the time of operation. However, in general it may be concluded that the surgeon, though very guarded in his prognosis, should generally be biased in favour of operative treatment, and should urge the same when both local and general conditions are favourable.

Indications. A. **In traumatic epilepsy.** According to the late Professor von Bergmann,[1] the indications for operation are as follows:—

(i) Recent cases with infrequent attacks of epilepsy.

(ii) Cases which have manifestations on the skull or scalp of previous injury.

(iii) Cases which have symptoms described as Jacksonian in character.

The suitability of a case for operative treatment hinges to a great extent on the presence or absence of cortical scarring and tract degeneration. If such changes are present, there can be but little expectation of ameliorating the patient's condition. In favourable cases, and especially in those that fulfil the indications laid down by von Bergmann, considerable improvement may be attained by adopting operative measures, with now and again a complete cure.

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[1] *System of Surgery,* vol. i.

In order to avoid disappointment, it should be explained to the patient, or patient's friends, that one of the three following results may be anticipated:—

1. A complete cure, for which it is necessary that favourable local conditions should be found, and that the patient should be so circumstanced as to be enabled to take complete rest, physical and mental, for one year after the date of the operation.
2. An alleviation of symptoms, the fits becoming less frequent and less severe, and the general mental and physical condition much improved.
3. A temporary improvement only, the symptoms recurring at a later date, but the fits, &c., not more severe than before.

B. **In traumatic insanity, &c.** Powell[1] pointed out that, in the very great majority of cases of traumatic insanity, the injury is comparatively superficial, resulting in depression of the bone, pachymeningitis, osteosclerosis, &c., and that only in a very few cases is the deeper cerebral tissue diseased. In 67 cases, 27 showed depressed bone, 15 osteophytes or splinters, 4 cysts, and 7 pachymeningitis.

Duret[2] draws attention to three main points: the great nervous sensibility of the dura mater, the absence of cerebral changes, and the almost instantaneous cure of some cases after trephining and removal of the irritating cause. He argues that the nervous phenomena in traumatic insanity are, in most cases, reflexly due to meningeal irritation.

All available evidence tends to show that the opinions of Powell and Duret, with regard to the presence of an exciting cause, are correct, such conditions being found in a large proportion of cases. Operative treatment is indicated, therefore, in all cases where the history of the case or the local conditions suggest the possibility of some local pathological lesion.

Operative measures to be successful must be carried out at an early stage of the trouble, before cortical degenerative changes have had time to occur.

C. **In general paralysis of the insane.** Claye Shaw[3] writes: 'I am quite sure that a surgical operation should only be resorted to when other remedies have failed, but if it be granted that pressure exists in

[1] *Traumatic Insanity,* Oxford, 1893.

[2] *Sur les traumatismes cérébraux.*

[3] *The Journal of Medical Science,* October, 1894.

acute insanity, either of the excited or depressed type, and ordinary measures seem useless, it would appear that nothing is left but the operation.' Some Continental surgeons are more insistent on the urgency of adopting operative measures in the earlier stages of this disease. In the experience of the writer, the early results of operation are fairly favourable, but no permanent benefit has been obtained.

In the operative treatment of traumatic epilepsy and insanity, the surgeon has evidence of external injury, the lesion varying from a scalp-scar adherent to the bone to an extensive osseous deficiency. The operations suited to these conditions are described below. In the surgical treatment of general paralysis 'decompression' operations are indicated, for which reference should be made to p. 391.

Operation. Though the operative details vary according to the circumstances of the case, the preliminary details are identical. The scalp is shaved and cleansed in the usual manner, the head enveloped in gauze, and the scalp-tourniquet applied (see p. 367).

The formation of the scalp-flap. *When the scalp is adherent to the bone,* the incision, carried throughout down to the bone, is made in such a manner that the scalp-flap, when turned down to its base, will permit not only of the detachment of the scar but also of the complete exposure of the neighbouring portion of the skull. In the region where the scalp was adherent to the bone all fibrous tissue and thickened pericranium are carefully dissected away to allow of adequate inspection of the bone itself.

When the scalp is adherent to dura or brain, as the result of the osseous deficiency, the edge of the knife should be directed towards the under aspect of the flap, and the flap carefully peeled away from the region of the gap and from adherent membranes, &c.

The examination of the bone. Careful search is made for a fissured or depressed fracture or other evidence of osseous lesion.

When no fracture is found, the question arises as to whether further measures are indicated or not. Although it cannot be denied that fits, &c., may arise merely as a result of the adherence of the scalp and bone, yet it is clearly established that such cases are exceedingly rare. As a general rule, therefore, the operator should trephine over the cortical area from which the trouble appears to emanate in order to exclude the possibility of the existence of depression of internal table, subdural hæmatoma, arachnoid cyst, &c.

When a fissured fracture is found, the bone should be trephined where the line of fracture crosses that region of the brain from which the symptoms appear to originate.

When a depressed fracture is found, the trephine is applied in such a manner that the trephine circle just includes the outer segment of the depression. During the trephining, special care must be taken to avoid damage to the dura mater which is probably adherent to the under aspect of the bone. After removal of the disk, the dura is stripped away from the bone and the depression rectified with the elevator and craniectomy forceps (see Fig. 212). In the event of failure to lever the depression outwards it will be necessary to cut away the whole of the depressed bone. De Vilbiss's forceps enable the operator to cut a narrow channel around the affected region, after which the isolated piece of bone can be readily removed. In any case, it is absolutely essential that a good view be obtained of the underlying dura.

When there is osseous deficiency, it will be found that the gap in the bone is filled up with dense fibrous tissue, adherent to the margins of the bone and possibly to both dura and brain as well. It is absolutely essential that this tissue should be removed, for all available evidence points to the fact that meningeal irritation is the main cause of the fits, &c.

The removal of the fibrous tissue is best carried out by beginning at the most promising part of the gap, detaching the tissue adherent to some more prominent portion of bone, and exposing the underlying dura mater. The dura is then separated from the bone in a direction away from the centre of the gap, and the craniectomy forceps applied till sufficient room has been obtained to allow of the introduction of some blunt instrument and the insinuation thereof between the scar tissue and the dura mater. It now remains to remove the central mass of fibrous tissue, a simple procedure when it is not adherent to the dura or brain, and carried out as follows: The dura mater and scar tissue are separated from one another, the scar tissue seized with pressure-forceps, lifted up, detached from the margins of the gap and removed. In the more complicated cases, where the scar tissue is adherent to the dura mater and brain, careful dissection is required. In most cases it is necessary to remove that part of the dura mater which is included in the scar. The cerebral substance should be carefully protected (see below).

The treatment of the dura mater. When the dura has not been injured during the process of exposure, is pulsating freely and presenting a normal appearance, preparations can be made to close in or protect the deficiency in the vault.

When the dura bulges outwards, and when, in other respects, the indications point to an increase of intradural pressure, the membrane is incised crucially and further investigation carried out in the search for a subdural hæmatoma, arachnoid cyst, or other lesion. A hæmatoma is washed out and drained; an arachnoid cyst is either shelled out entire or treated by excision of the parietal wall, with subsequent drainage.

When the dura is thickened, matted, and adherent to the brain, it should be picked up at the least adherent part and carefully dissected away, exposing the loose mesh-work of the pia-arachnoid region. The surface of the brain being so brought into view, the use of the scalpel and dissecting forceps may be further required to remove all tags and shreds of matted tissues, this process being continued till a reasonably healthy region has been brought into view.

The treatment of a cortical scar. There is no reason why the more superficial portion of a cortical scar should not be freely removed, but unfortunately, such removal is almost necessarily followed by the formation of another scar, at least as extensive as the original fibroid condition. The removal of cortical scars has, therefore, justifiably fallen into disrepute, and most surgeons content themselves with an exposure of the pia-arachnoid region, the actual cerebral substance being left untouched. All hæmorrhage must be arrested, bleeding points being clamped or underrun and tied with fine catgut. The occurrence of hæmorrhage after the reposition of the scalp favours the formation of fresh adhesions.

The prevention of fresh adhesions between the dura and the brain, and between the dura and the scalp. Many measures have been advocated. It has been recommended that some foreign substance should be inserted, such as fresh egg-albumen, gutta-percha, silver and gold foil, between the brain and the dura, the latter membrane being gently lifted up and the medium insinuated beneath. Experience shows, however, that all these substances are comparatively useless, being either invaded or surrounded by granulation-tissue and, later on, absorbed or enclosed in dense fibrous tissue. English[1] says, 'It is useless to talk about the prevention of adhesions; they will form in spite of anything that may be done.' In suitable cases, however, the adhesion of the dura to the brain may be prevented by stitching that membrane to the pericranium.

The use of transplants of fat or fat attached to fascia lata, both being transplanted, to repair the defect has been used with considerable success in preventing such adhesions.

The prevention of adhesions between the dura and brain on the one hand and the scalp on the other, and the closure or protection of gaps in the skull, are subjects so intimately allied that they are necessarily considered together.

[1] *Lancet,* Feb. 27, 1904, p. 563.

THE CLOSURE OR PROTECTION OF DEFECTS IN THE SKULL

Indications. Operative measures for the closure or protection of gaps in the skull are indicated in the following conditions:—

(i) Large defects, post-operative or traumatic.

(ii) Small defects situated over exposed portions of the skull or over the more important regions of the brain.

(iii) Both large and small defects associated with chronic fixed headache, insanity, Jacksonian epilepsy, &c.

(iv) Certain congenital deficiencies in the vault.

Small defects, unless situated in exposed regions or associated with symptoms, require no active treatment. The gap becomes diminished in size by the inward growth of the surrounding bone and by the development of fibrous tissue of such density that the underlying structures are effectually protected.

Methods. The methods that have been adopted for the closure or protection of gaps in the skull may be classified as follows:—

(1) The formation of bone-flaps—

Derived from the neighbouring portion of the skull.
Derived from some other bone of the patient.
Derived from the bones of a freshly-killed animal.

(2) The interposition of plates of some foreign material between the scalp and the bone, or the insertion thereof into the osseous deficiency.

Bone-flaps. *The osteoplastic method of König and Müller.*[1] Two flaps are formed in the manner described below and the two interchanged in position. A Ω-shaped flap, comprising the whole thickness of the scalp, is turned down so as to expose the region of the deficiency. The incision is carried down to the bone throughout, and should lie about ½ inch away from the margins of the gap. The flap is carefully dissected from underlying structures to which it may be adherent, and every precaution taken to avoid damage to those arteries that enter along the base of the flap and which minister to its vitality. All bleeding points are clamped and tied.

A second flap is framed from the scalp immediately to one side of the first flap. This second flap corresponds in size and shape to the one already made, but differs in having its base pointing in the opposite direction. It is also peculiar in that it consists of the whole thickness of the scalp, together with the external table of the skull. The scalpel is carried down to the bone, and the margins of the incision retracted in such a manner as to allow of the application of the hammer and chisel.

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[1] *Centralbl. für Chirurgie,* 1890, pp. 65 and 497.

The external table is cut through along the line of the scalp incision, and split away from the rest of the bone. The two flaps are then interchanged in position and sewn down with salmon-gut sutures.

The osteoplastic flap is by no means easy to frame, the external table tending to break up during the process of separation; moreover, its formation is confined to those parts of the skull in which the two tables are separated by diploic tissue. The operation is, therefore, limited to the occipital, parietal, and frontal regions. The frontal region should, however, be generally excluded from participation in this mode of treatment on account of the deformity and scarring that necessarily ensue.

Many cases also have been recorded in which the raw surface of the bone-flap has contracted fresh adhesions to the underlying parts, thus defeating one of the main objects that the surgeon has in view.

In suitable cases, however, a good result may be anticipated. Asepsis is absolutely essential.

Bone-flaps derived from the bones of the patient, or from those of a freshly-killed animal. A bone-graft may be cut from the tibia of the patient or from any suitable bone of a freshly-killed animal. The gap in the skull is first exposed, the margins refreshed, and the size and shape estimated. The bone-graft is then cut from the other bone, suited in every respect to the deficiency that is to be filled in, inserted into the gap, and sewn into position. The ultimate results obtained by this method are by no means satisfactory. They may be classified as follows:—

(*a*) The bone-graft may retain its vitality and completely close in the gap.

(*b*) The graft may act as a foreign body, become invaded by granulation-tissue and be more or less completely absorbed.

(*c*) In the event of the slightest failure in aseptic technique, suppuration occurs, and continues till the wound has been reopened and the graft removed.

The attendant difficulties and frequent failures in these auto- and hetero-transplantations of normal bone led to the utilization of decalcified, calcined, and boiled bone-plates. Between these media there is but little to choose, for it is generally accepted that bone-grafts, of whatever nature, usually act merely as a scaffolding medium for the formation of fibrous tissue. The absorption of decalcified bone-grafts results, according to Barth, from the absence of the calcium salts which are so essential to the life of the graft and the formation of new bone. Calcined and boiled grafts presumably owe their ultimate absorption to the fact that the bone-cells are destroyed in the process of graft preparation.

Opinions are correspondingly divergent as to the most suitable method of protecting or closing in the gap in the skull. Senn recommends calcined bone, Mertens and Westermann boiled bone, whilst Leedham-Green [1] advises the König-Müller flap in the first case, and, in the event of failure, boiled bone-grafts.

Plates of some foreign material. Gold plates are expensive, and present no material advantage over the cheaper metal, silver. Aluminium is strong and light, but insufficiently malleable. Celluloid is strongly recommended by Fraenkel, Pringle,[2] and others. Pringle uses plates about 1/16 inch thick, moulded slightly by immersion in hot water, and then inserted within the margins of the gap. He reports favourably on the results obtained.

In those cases, however, in which the writer has deemed it necessary to close in or protect gaps in the skull, the following method has been found to give satisfactory results:—

The plates utilized are of pure annealed silver, 9/1000 inch in thickness (No. 2 Birmingham, Metal Gauge). The plates are light and of fair malleability. Supposing now that it is required to protect a deficiency in the vault—irregular in shape, round or oval, it matters not—the maximum antero-posterior and vertical diameters are measured before operation, and a piece of silver is cut out which is about ½ inch longer in both diameters. The convexity of the skull in the region of the gap is roughly estimated and the plate hammered into corresponding shape. This process is readily carried out by laying the plate on a heavy leaden base and hammering to the required curvature. The convexity is regulated by the site of application of the blows, the heavier being applied to the central or apical portion of the plate, the weaker to the periphery. A rough general convexity is so produced. The edges of the plate are smoothed with the file, and three or four holes bored through it to allow of the escape of any blood or cerebro-spinal fluid that may collect beneath it after application.

The plate is boiled and then applied as follows: The osseous defect is fully exposed by the formation of a scalp-flap (not including the pericranium) framed by means of an incision which lies fully 1 inch distant from the margins of the osseous deficiency. The flap is turned down to a base which is situated not more than ½ inch below the lower border of the gap. The pericranium is stripped away towards the periphery. The plate is then applied so that it rests below against the base of the scalp-flap, lies throughout between the scalp and bone, and overlaps the margins of the gap by about ½ inch. The pericranium is heaped up around and over the margins of the plate, and the scalp-flap replaced. The plate is maintained in position by the support received below from the base of the flap, marginally by the pericranium and generally by the reposition of the scalp-flap. In the process of time, new bone is formed by the pericranium, this and the fibrous tissue developed along the line of the scalp incision fixing the plate accurately and firmly in position.

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[1] 'On the Closure of Traumatic Defects in the Skull,' *Brit. Med. Journ.*, 1905, p. 819.

[2] 'On Closure of Gaps in the Skull,' *Brit. Med. Journ.*, 1906, p. 246.

In the majority of cases in which this method has been carried out the patients have not complained of any inconvenience, either from the weight of the plate or from other cause. Needless to say, absolute sterility of the field of operation and of all media is essential. In the event of suppuration, however slight, it will become necessary to reopen the wound and remove the plate.

Results. Of operations for traumatic epilepsy. The immediate results of operation are undoubtedly very satisfactory, but the more remote results are by no means so encouraging. For some weeks or months after the operation there is nearly always a decided improvement in the condition of the patient, but a subsequent relapse is frequently noticed. Of 12 cases that have come under the care of the writer a complete cure was obtained in 2, both these patients having been kept under observation for a considerable period of time. In 5 cases a definite improvement in the conditions was obtained, whilst in 5 others there was no material change.

The early benefit that results, and the subsequent relapse that so frequently obtains, suggest strongly that the recurrence of the trouble arises from the re-formation of adhesions. It is our technique that is at fault in the main. There is, however, every reason to believe that fairly satisfactory results may be obtained if suitable cases only are submitted to operation. Statements with regard to prognosis must always be of the most guarded nature.

Of operations for traumatic insanity. In the 67 cases reported by Powell,[1] death occurred in 5. In the 62 recoveries, the following results were obtained:—

41 cases of mental recovery.
12 cases of mental improvement (great).
5 cases of mental improvement (slight).
4 cases in which there was no change.

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[1] *The Treatment of Traumatic Insanity.* Oxford, 1893.

CHAPTER VI

OPERATIONS FOR INTRACRANIAL SUPPURATION

Indications. With regard to the desirability of operative treatment for pus pent up within the skull, no special indications are required. Free drainage must be supplied at the earliest possible moment, granting, of course, that the general condition of the patient is compatible with operative interference, and that the site of infection can be diagnosed with a reasonable degree of accuracy. It must, however, be pointed out that even when the patient is almost moribund from the presence of a cerebral or cerebellar abscess, the evacuation of the pus not infrequently leads to the happiest results. Furthermore, when the localizing features are but ill defined, much may be done to diminish the general increase in the intracranial pressure, thus allowing of time in which to perfect the diagnosis and adopt further measures.

In other words, experience shows that but few cases can be regarded as absolutely hopeless, however desperate they may appear to be.

The majority of cases of intracranial suppuration that come under the care of the surgeon are either secondary to chronic middle-ear disease, or prolonged suppuration in the accessory sinuses of the nose. These are dealt with in Vol. IV.

Only two varieties of cases of intracranial suppuration will be considered in this section, those which are traumatic in origin and those which, though apparently secondary to aural or nasal disease, are best treated by trephining and exploration of the brain. For instance, the surgeon often prefers to explore directly for a temporo-sphenoidal abscess, postponing the mastoid operation to a future date. Such a course presents certain obvious disadvantages, but it is one that is called for under certain circumstances. Firstly, when the general condition of the patient prohibits the prolonged procedures essential to the mastoid and similar operations; and secondly, when the operator, from inadequate knowledge of the minute anatomy of the middle ear, prefers to avoid a search for the abscess cavity along the 'stalk of the abscess.'[1]

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[1] Ballance (*Some Points in the Surgery of the Brain,* p. 95) first pointed out that most brain abscesses secondary to disease of the bones of the skull are mushroom-shaped, the narrow portion or stem being attached to the dura at the original site of infection. The stalked form of abscess is 'quite comparable, as to its mode of formation, to a superficial cervical abscess connected by a narrow track to a focus of disease beneath the deep fascia.'

Two further points require consideration with regard to the relative advantages of trephining without primary mastoid operation.

Firstly, with regard to the adequacy of the drainage supplied. Macewen[1] points to the desirability of exploring and draining a temporo-sphenoidal abscess through the squamous bone, and lays stress on the incomplete nature of the drainage supplied after exploration through the tegmen tympani. Again, when the evacuation of a cerebellar abscess is under consideration, it would appear that more efficient drainage can be established when the operation is carried out through the lower cerebellar region than through the eroded posterior wall of the middle ear.

Secondly, it should be noted that an unsuccessful attempt to find the abscess after exploration through the tegmen tympani, or other part of the petrous bone, carries with it an appreciable risk of meningeal and brain infection, insomuch as the exploration is conducted from the infected middle ear. Exploration through the 'clean' squamous and cerebellar regions presents no such disadvantages.

Each case must be treated on its own merits, the surgeon being naturally disposed to adopt those measures with which he is most familiar.

The following conditions require consideration:—

1. Extra-dural suppuration.
2. Meningitis.
3. Abscess of the brain.
4. Hernia cerebri.

OPERATION FOR TRAUMATIC EXTRA-DURAL SUPPURATION

Operation. After the application of the scalp-tourniquet, a scalp-flap is framed and turned down, the incision being so planned as to fully expose the diseased area of bone. The subsequent measures vary according to the conditions present.

Where no fracture is found, but where the appearance of the bone and pericranium suggests the possibility of an extra-dural focus of pus, the pin of the trephine is placed over the centre of the unhealthy bone, the disk of bone removed, and the pus allowed to escape. With the aid of the dural separator the extent of the collection is estimated, and the opening in the skull enlarged with the craniectomy forceps in the required direction. It is essential that adequate drainage should be supplied. The pus should be wiped away with the sponge and gauze, and no irrigation used. It has been recommended that the dura mater should then be lightly scraped with Volkmann's spoon. Such measures are, however, to be condemned, insomuch as the sodden dura may be injured and the patient thereby exposed to the risk of a general meningeal infection. After thorough exposure and cleansing, the abscess cavity is plugged lightly with narrow strips of gauze, the ends of which are brought out at the most convenient and dependent part of the scalp-flap.

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[1] *Pyogenic Diseases of the Brain and Spinal Cord,* p. 313.

In the event of the surrounding bone presenting an unhealthy appearance, the external table and diploic tissue must be freely removed. The external table can be cut away with the hammer and chisel, with the trephine, or with rose-headed burrs and drills. If the condition of the patient allows of the requisite prolongation of the operation, the trephine should be used, the external table of the skull being cut away till a region is attained where the bone appears normal. The diploic tissue is scraped away with Volkmann's spoon, and the exposed internal table sponged with undiluted carbolic acid, every precaution being taken to protect the dura mater from contact with the acid. The whole region is then sponged over with a weak antiseptic solution and lightly packed with gauze.

If a fissured fracture be found, the pin of the trephine is applied where the line of fracture crosses the central part of the unhealthy bone.

If the skull be depressed or comminuted, the fragments are elevated or removed, with or without trephining, and the abscess treated as described above.

OPERATIONS FOR MENINGITIS

Anatomical considerations and pathological experience evidence the futility of operative measures when the infection is widespread. It has been proposed that, even under such adverse circumstances, a counter-opening should be made, either opposite to the site of primary injury or in the cerebellar region, irrigation being then carried out between the two holes. Such measures are, however, unwarrantable and impracticable—unwarrantable because the irrigation must inevitably infect the whole of the subdural space intervening between the two holes, impracticable because the outward bulging of the brain in the region of the trephine holes effectually prohibits all such measures.

The surgeon has, therefore, in the operative treatment of meningitis, two main objects in view:

(*a*) To lessen the risk of a general infection by early exploration in all doubtful cases.

(*b*) To establish adequate drainage.

These two objects being fulfilled, some further aid may be obtained by lumbar puncture and by serum-therapeutic treatment.

With regard to the necessary operative measures, reference should be made to the section dealing with the operative treatment of fractures of the skull.

OPERATIONS FOR ABSCESS OF THE BRAIN

Acute traumatic abscess. An acute abscess arising from direct infection from a compound fracture of the vault usually develops within two weeks after the accident, being, in fact, more after the nature of a meningo-cortical abscess than a brain abscess proper. Now and again, cases are reported in which the purulent collection was late in development, firmly encapsuled, and situated deep in the white substance of the brain. Such cases are very rare.

The measures that can be adopted for the evacuation of a meningo-cortical abscess vary according to the condition of the overlying bone.

Where no fracture is found, the bone is trephined over the region from which the trouble appears to emanate, and the dura investigated. If that membrane be already lacerated by depressed fragments of internal table, an enlargement of the rent with blunt-pointed scissors will suffice to fully expose the abscess. Under other circumstances, the bulging membrane is freely incised and the abscess laid bare. Should it be found that free drainage cannot be supplied through the trephine hole, the bone must be cut away in the required direction and the dural incision prolonged accordingly. The pus is sponged away and the cavity lightly packed with gauze. Irrigation is contra-indicated on account of the attendant risk of meningeal infection.

Where a fissured fracture is found, the skull is trephined where the fracture crosses the region from which the trouble appears to arise.

Where a comminuted fracture is found, the fragments of bone are elevated and removed until sufficient exposure of the dura mater has been obtained.

Temporo-sphenoidal abscess. After the usual preparatory treatment, a point is chosen on the surface of the scalp which lies between 1½ and 2 inches above the centre of the external auditory meatus. This point may be recognized on the bone by introducing a bradawl through the scalp in such a manner as to indent the external table. A suitable scalp-flap is turned down and the trephine applied. The trephine should present a diameter of not less than 1 inch. In the squamous region of the skull the two tables are in practical apposition, and every precaution must therefore be taken to avoid damage both to the posterior branch of the middle meningeal artery, which ramifies in the immediate neighbourhood, and to the bulging dura mater. After the removal of the disk of bone, the dura is inspected; absence of pulsation, marked outward bulging, and loss of lustre indicate the probable adjacency of the abscess cavity. The membrane is crucially incised, any meningeal vessels that cross the proposed line of dural section being first ligatured or underrun on either side of that line. The scalpel is applied lightly to the dura, and, as soon as the pia-arachnoid is exposed, the section completed with the blunt-pointed scissors. By adopting these precautions there is but little chance of causing troublesome complication by damaging superficial cerebral veins.

The four dural flaps are turned aside and the cortex exposed. At the very apex of the bulging brain, and avoiding all visible vessels, a large trochar and canula or Horsley's pus evacuator (see Fig. 220) is introduced and passed for not more than 1½ inches, in a direction slightly forwards and inwards, parallel to the tegmen tympani. The blades of the evacuator must be opened 'once for each quarter of an inch of brain substance penetrated' (Macewen). If the trochar and canula be used, similar precautions must be taken. In the event of failure to find the abscess at the first attempt, the evacuator is withdrawn, introduced at the same site as before, but passed in other directions, directly inwards, forwards, and backwards, in each case for not more than 1½ inches. By wide separation of the blades of the evacuator the pus is allowed to escape, to be immediately sponged away by the assistant. Irrigation of the cavity should never be carried out, the process being exceedingly difficult to accomplish effectually, on account of the narrowness of the track which leads from the abscess cavity to the surface of the brain, whilst there is furthermore considerable risk of infecting the surrounding meningeal territory.

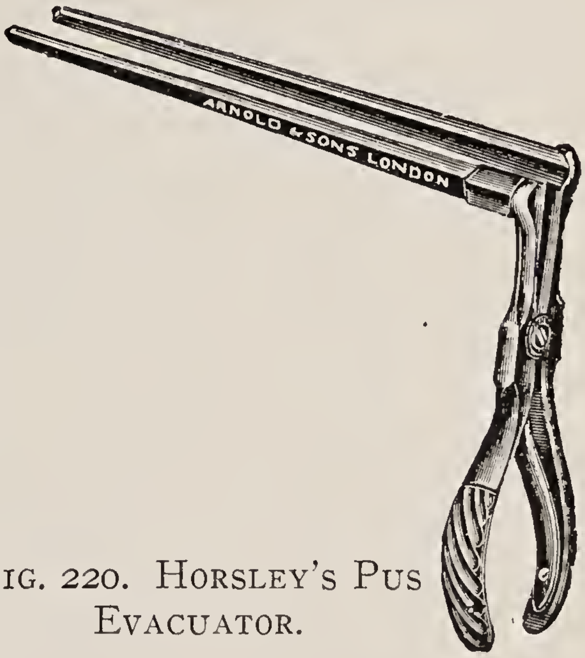

Fig. 220. Horsley's Pus Evacuator.

Before the withdrawal of the evacuator a drainage tube is inserted, projecting into the abscess cavity, and brought out through the scalp-flap. The tube may be shortened daily, to be withdrawn finally after four days or more, according to the progress of the case.

Before dealing with cerebellar abscess, it will be necessary to allude to certain points in the operative technique peculiar to the treatment of chronic abscesses (encapsuled). Abscesses of this nature may occur in any part of the brain, and the surgeon must be prepared to deal with the same.

Chronic encapsuled abscess. Both the trochar and canula and Horsley's pus evacuator have a great tendency to merely impinge against and push aside the dense wall of a chronic abscess without penetrating it. If, from the nature of the case, it be suspected that the abscess is of the chronic type, it should be explored for and treated after the following manner: After exposure of the brain, a small blunt probe is introduced in the direction of the abscess and the brain probed until the resistance of the abscess-wall is encountered. A grooved director is passed along the probe and the latter instrument withdrawn. By gentle side-to-side movements the passage through the brain is enlarged until a view can be obtained of the abscess-wall. A head-lamp will be found of great assistance. The margins of incision into the brain are held aside with small retractors, and the wall of the abscess incised with tenotomy knife or small scalpel. It is now possible to introduce a drainage tube. In the experience of the writer, however, it has been found that such procedures seldom lead to a satisfactory result, the tube being extruded and the abscess filling up again. For instance, a case of frontal abscess was twice incised and drained before it was realized that a cure could not be brought about in this manner. Wherever possible, therefore, the abscess should be completely removed. The margins of the incision through the wall of the abscess are seized with narrow-bladded clamps, gentle traction applied, and the surrounding brain substance carefully peeled away with the handle of the scalpel or periosteal elevator. As a rule, there is no great difficulty in carrying out this proceeding, and the hæmorrhage is seldom severe. After complete removal of the abscess-wall a drainage tube is introduced and the cavity lightly packed with gauze. The packing is allowed to remain for twenty-four to thirty-six hours, after which it is withdrawn and the space again lightly plugged. The repacking is continued till the cavity is practically obliterated. The closure often takes place with astonishing rapidity, and results from the falling together of the surrounding brain, from the formation of fibrous tissue, and the dragging in of the overlying scalp.

Cerebellar abscess. The abscess usually occupies the antero-external aspect of the lateral lobe of the cerebellum. It can be drained with advantage below the level of the lateral sinus and behind the posterior border of the mastoid process. A scalp-flap is framed as follows: The skin incision extends from the middle line, 1 inch below the external occipital protuberance, along the superior curved line of the occipital bone, to the upper and posterior part of the mastoid process, and then, in a downward direction, to the apex of that process. The incision is carried throughout down to the bone, and the cutaneo-muscular flap detached with the scalpel and periosteal elevator. The flap must be carried down as rapidly as possible, for the hæmorrhage is severe. The bleeding not only occurs from divided occipital vessels but also from the mastoid emissary vein. Bleeding from the former source is controlled by clamps, that from the latter by introducing a small blunt probe into the foramen and working it round so as to destroy the lining membrane and so induce coagulation. More permanent occlusion can be brought about by blocking the foramen with a small piece of catgut, well rammed home.

The trephine is applied so that the circle falls immediately short of the lateral sinus above and the posterior border of the mastoid process in front. The trephine should be manipulated in the direction depicted in Fig. 222. It is necessary to remember that the wall of the cerebellar fossa is very thin. After the removal of the disk of bone, the gap may require to be enlarged with the craniectomy forceps. The dura is incised after the manner described in the operations for temporo-sphenoidal abscess, and the search for the abscess carried out with the same general precautions.

In this case, however, the evacuator is passed in the forward and inward direction towards the posterior border of the petrous bone. The abscess should be reached within 1½ inches from the opening in the skull. Before the removal of the evacuator a drainage tube is inserted, and the cavity drained as described previously.

Ballance[1] has recently pointed out that cerebellar abscesses are occasionally of a bifid nature, two cavities being superimposed and communicating with one another by means of a narrow channel. Any failure at symptomatic relief after drainage of a cerebellar abscess should suggest the possibility of the presence of such a condition.

Frontal abscess. Abscesses of the frontal lobe are most commonly secondary to disease of the frontal sinus. The abscess is, however, usually situated so far back in the frontal lobe and connected with the source of the trouble by so long a track or stalk of infection that considerable difficulty may be experienced in attempted drainage from the frontal or nasal regions; moreover, all operations carried out from the frontal region result in great deformity. The larger abscesses also give rise to such localizing symptoms, by reason of the backward pressure exercised on the corona radiata from the motor region, that the operator is frequently induced to approach the abscess cavity from the temporo-frontal region. In this situation the bone is thin, the operation can be conducted through the fibres of the temporal muscle, excellent drainage can be supplied, and no conspicuous scar results.

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[1] *Some Points in the Surgery of the Brain.*

For a general description of the intermusculo-temporal operation the reader is referred to p. 392. In this case the operation is carried out after the same general principles, with the exception that the field of operation is shifted further forwards. The skin incision starts at the external angular frontal process, curves along the temporal crest, and terminates in front of the ear. The temporal fascia and muscle are divided by an incision which is carried down to the bone and which passes in a direction obliquely downwards and backwards, so as to expose the front part of the temporo-frontal region. The bone is trephined and the search for the abscess carried out after the manner described in dealing with temporo-sphenoidal abscesses.

Difficulties and dangers. *Failure to find the abscess* is usually due to one of the following causes:—

(*a*) The abscess may be missed if the localizing features are misleading, if the abscess be small, and if the exploring instrument be passed in the wrong direction or to an insufficient depth.

(*b*) The abscess may be traversed but not tapped if unsuitable exploring instruments are used,—an aspirating syringe, for instance, through which the thick pus is unable to escape. Even when suitable instruments are used the attempt to evacuate the abscess may fail if the operator does not carry out what may be called a ‘system of progressive exploration,’ that is to say, the periodical opening of the blades of the evacuator (see p. 419).

(*c*) The abscess may be encountered but not penetrated if the surgeon has to deal with a chronic abscess, the wall of which is merely pushed aside by the advancing instrument. Such an occurrence may be prevented by carrying out the procedures advocated in the section dealing with the operative treatment of such conditions (see p. 420).

Leakage into the neighbouring pia-arachnoid is a complication that is fortunately of infrequent occurrence, mainly owing to the fact that the general increase of intracranial pressure so causes the brain to bulge outwardly against the trephine hole that the subdural and subarachnoid spaces are practically cut off from the field of operation. Furthermore, in some cases, and especially when the abscess is situated near the surface of the brain, adhesions have formed between the membranes, cementing them together and affording an efficient barrier to meningeal infection.

Osteomyelitis of the diploic tissue can generally be prevented by providing efficient drainage, by protecting the exposed bone with strips of gauze, and by touching up the exposed diploic tissue with undiluted carbolic acid.

Perforation of the ventricular space may occur under two conditions: (1) when the abscess is associated with internal hydrocephalus, and (2) when the exploring instrument is introduced too far. The latter complication can be prevented by carrying out the regulations laid down in the section dealing with temporo-sphenoidal abscess.

Hæmorrhage is seldom serious if the dura mater be incised in such a manner as to avoid injury to meningeal arteries, and if the evacuator be introduced so as to avoid the superficial cerebral veins. Hæmorrhage is most likely to result during the complete removal of a chronic abscess. In such cases every precaution must be taken to keep close to the wall of the abscess.

Respiratory failure is by no means an unusual feature in trephining, especially under two conditions: (1) when there is a marked increase in intracranial pressure, (2) when the operation is conducted in the cerebellar region. Respiratory failure should act merely as an incentive to the surgeon to complete the trephining as soon as possible and so relieve the compression of the brain. In the more serious cases, artificial respiration may be necessitated.

Results of operations upon brain abscess. It has only been recognized recently that an uncomplicated brain abscess—not associated with lateral sinus thrombosis and the like—offers by no means an unfavourable prognosis. Sir William Macewen,[1] to whom so much is due in the advancement of cerebral surgery, states that 'an uncomplicated cerebral abscess, whose position is clearly localized, if surgical measures are adopted for its relief at a sufficiently early period, is one of the most hopeful of all cerebral affections.' The same authority writes, 'After evacuation of the abscess, not only is the patient likely to recover, but in many cases it leaves no perceptible bodily or mental changes.'

The following statistical table, culled from Macewen's published reports, will demonstrate sufficiently the results that can be obtained by early operative treatment:—

	Cases.	*Operated on.*	*Cured.*	*Died.*	
Extra-dural abscess	5	5	5	0	
Leptomeningitis .	12	6	6	6	(all without operation)
Brain abscess—					
Meningo-cortical	4	4	4	0	
Temporo-sphenoidal	10	9	8	2	(one without operation)
Frontal . .	2	1	1	1	(without operation)
Parietal . .	1	1	1	0	
Cerebellar . .	8	4	4	4	(two without operation)

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[1] *Pyogenic Diseases of the Brain and Spinal Cord.*

Röpke,[1] cited by von Bergmann, collected 142 cases of cerebral abscess, 59 of which recovered after operation, and of these over 40% were permanently cured.

Delvoie,[2] also quoted by von Bergmann, reports 21 cases of superficial cerebral abscess, acute in nature, with 15 recoveries, and 35 cases of deep and chronic abscess with 19 recoveries.

Ballance[3] collected 26 cases of cerebellar abscess, all of which were submitted to operation, with recovery in 10 and death in 16.

OPERATIONS FOR HERNIA CEREBRI

The protrusion of the brain through a gap in the osseous vault is the direct result of an increased intracranial pressure. To obtain some degree of protrusion is a result desired by the surgeon in the 'decompression' operations carried out for an irremovable brain tumour (see p. 434). A hernial protrusion also occasionally occurs in traumatic affections as the result of hæmorrhage within the skull with its attendant œdema and softening of the brain. Sepsis is, however, by far the most common cause of hernia cerebri, so much so that hernia cerebri is often regarded as implying necessarily a septic condition. Two main causes may be cited for such conditions—abscess of the brain and local or general infection of the brain, the latter state usually arising in connexion with a compound fracture of the vault. In the former case, the abscess must be found and drained, when the protrusion will subside under favourable local and general conditions. In the latter case, desperate measures may be adopted by cutting away the protrusion, in the hope that part of the disease may be removed. Such a course is justifiable, and, indeed, called for, when nothing can be done to treat the cause and when the protruded portion of the brain does not include such cortical regions as are responsible for the more important functions, *e.g.* the motor area.

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[1] *System of Surgery,* vol. i, p. 281.

[2] *System of Surgery,* vol. i, p. 281.

[3] *Cerebellar Abscess secondary to Middle-ear Disease.*

CHAPTER VII

OPERATIONS FOR TUMOURS OF THE BRAIN

Indications. The indications for operation may be arranged in two groups:

Those for radical operation aiming at the removal of the tumour.

Those for palliative operation aiming at the relief of pressure.

For the radical operation. According to Risien Russell,[1] the following are the main indications:—

(i) Cases in which the tumours can be accurately located.

(ii) Cases in which the tumour is situated in an accessible region. The more favourable sites are the surface of the cerebrum, the lateral lobe of the cerebellum, and the 'lateral recess' (cerebello-pontine angle).

(iii) Cases in which there is reason to believe that the tumour is single and of such a nature that it can be removed from its bed. When the nature of the tumour is doubtful, anti-syphilitic remedies are usually and appropriately used. How long such remedies are to be continued is quite another matter. Sir Victor Horsley,[2] in 1890, at the International Congress, urged that a definite probationary period should be agreed upon, and suggested that, in an elementary case where no urgent symptoms like optic neuritis existed, surgical treatment should be employed after thorough medication had been applied for about six to eight weeks without appreciable benefit. No conclusion was arrived at. Allen Starr concludes that the surgeon should be invited to consultation in the case after three months of unsuccessful medicinal treatment. Risien Russell points out that, in some cases of gummatous disease, the administration of anti-syphilitic remedies exercises no result worth speaking of, and, whilst objecting to any time-limit, urges the importance of surgical intervention, each case being judged on its own merits.

(iv) Cases in which there is reason to believe that the removal of the tumour will not greatly imperil the patient's life, and furthermore will not result secondarily in the development of paralysis, aphasia, &c.

For the palliative operation. The following are the main indications for operation:—

(i) To prolong life.

(ii) To alleviate severe and persistent headache, vomiting, &c.

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[1] *Brit. Med. Journ.*, October 26, 1907.

[2] *Ibid.*, August 25, 1906.

(iii) To stop the fits.

(iv) To save the sight.

(v) And, in general, to benefit the patient by reducing the intracranial pressure, even though it may be quite impossible to remove or even locate the tumour.

Of all the considerations enumerated above for which palliative measures are indicated there is no symptom which more urgently demands operation than optic neuritis. This question of sight-saving may be accepted as a basis on which to gauge the value of palliative measures in general, insomuch as the indications are equally referable to those other symptoms which result from the increase in the intracranial pressure.

It is obvious that no mere 'decompression' operation is advisable when the optic inflammation has progressed to atrophy, and even in the earlier conditions of the inflammation the cases must be carefully chosen.

Risien Russell[1] draws attention to the importance of differentiating between those cases of optic neuritis which result from toxic tumour products and those which are directly resultant upon the increase of intracranial pressure. In the former case trephining, without removal of the tumour, can give rise to no beneficial results. The difficulty consists in making this differential diagnosis, always a matter of considerable difficulty and usually impossible.

Herbert Bruce[2] admirably clinches this matter in the following words: 'As to the prediction of improvement of vision after trephining, everything depends on the condition of the disks. Yellowish white patches of exudate or white atrophic changes, especially when associated with macular changes, all indicate that the secondary changes in the disks will be permanent. In proportion to this development will the vision be impaired, whilst when the loss of vision has been dependent on the swelling of the disks, then not only is the sight saved but largely improved. In other words, one might say, therefore, that when the neuritis has not progressed on to atrophy the sight would be saved.'

RADICAL OPERATIONS FOR CEREBRAL TUMOUR

Operation. After the usual preparatory treatment and after the exposure of the dura mater, either by craniectomy or by craniotomy (see Chapter II), the question arises as to whether the exposure and removal of the tumour is to be proceeded with at once, or whether it is advisable to postpone further treatment till the patient shall have recovered from the shock attendant upon the dural exposure. The two-stage operation, first recommended by Horsley, is insisted on by some surgeons for all operations performed with the object of tumour removal. By others it is maintained that it is preferable to carry out the operation in one stage, on the ground that two anæsthetics and two operations present a greater risk to the patient's life. Possibly, when the conditions are altogether favourable, it is advisable to complete the operation in one stage, but, as the shock and loss of blood entailed during the first stage is considerable, as the operator cannot possibly foresee with certainty what lies beneath the dura mater, and as considerable time must elapse and considerable hæmorrhage result during the further procedures necessary in the reflection of the dura mater and the removal of the tumour, it follows that it is almost always advisable to conduct the operation in two stages. The second operation can be undertaken a few days later.

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[1] *Brit. Med. Journ.*, October 26, 1907.

[2] *Annals of Surgery*, 1907, p. 543.

Examination of the dura mater. Considerable help may be obtained by examination of the dura, both with regard to the localization of the tumour and investigation as to its nature. Pulsation may be abolished or diminished, and the membrane may bulge outwards in a degree proportionate to the size and site of the tumour. The membrane overlying a tumour may be œdematous or adherent; in colour, it may be anæmic from the pressure exercised upon it, reddened from increased vascularity, grey-brown from the immediate presence of a malignant tumour, plum-coloured from the adjacency of a subdural hæmatoma, or opaque from the presence of a subarachnoid cyst, &c.

Some evidence as to the nature of the tumour may also be obtained by palpation—fluctuation suggesting cyst-formation or hæmorrhage, ‘solidity’ pointing to the existence of a solid tumour.

Opening the dura mater. No definite rule can be laid down as to the manner in which the dura should be opened. Two methods are adopted —the crucial incision and the flap formation, each of which presents advantages. A crucial incision should generally be adopted. All meningeal vessels must be tied on either side of the proposed line of incision, preferably by means of a fully-curved needle, threaded with fine silk or catgut, passed in such a manner as to avoid puncture of the pia-arachnoid, and without injury to the superficial cerebral veins. The dural incision must always fall short of the margins of the deficiency in the skull by at least 1/3 inch, in order that accurate approximation may be secured after the removal of the tumour, if such a procedure should be necessary.

An incision is made with a sharp scalpel over the central part of the bulging membrane, and deepened till the pia-arachnoid is exposed. The margins of the dura are then lifted up with fine-toothed forceps, and the incision completed with the blunt-pointed scissors. If the brain bulges outwards to such a degree that the ready division of the membrane is impeded, a director is introduced beneath the dura and the membrane slit up with the knife.

The dural flaps are then turned outwards and the brain inspected.

Examination of the brain. If the tumour be not visible, further investigation may be carried out by palpation, digital and instrumental exploration, electrical stimulation, and *morcellement.*

Palpation may reveal the presence of a cystic or solid tumour.

Digital and instrumental exploration may be carried out when the surgeon has to deal with a subcortical tumour. This method, however, is not to be undertaken without adopting every precaution to avoid unnecessary damage to the brain substance. The exploration should invariably be preceded by incision with the brain-knife or scalpel, introduced in such a manner as to avoid injury to superficial cerebral vessels, and directed at right angles to the surface of the brain so as to cause the least possible injury to the corona radiata, &c. The margins of the incision are held aside with retractors and the finger gently inserted to find out whether the tumour is removable, further assistance being obtained by the introduction of a flat spatula or periosteal elevator.

Electrical stimulation may be used to see whether the brain exposed by the operation corresponds to the symptoms evinced by the patient. It has been stated that absence of response to the stimulation suggests strongly the presence of a regional subcortical tumour. With regard to the actual technique of electrical stimulation, Cushing[1] writes as follows: ‘In the electrical stimulation use a long glass unipolar electrode, carrying a fine platinum core coiled into a spiral at the end, according to Sherrington’s plan, in order to obviate the puncture of the pia-arachnoid. The other pole is attached to an extremity, preferably on the homo-lateral side. The current should be just strong enough to contract exposed muscle; some of the fibres of the temporal muscle are generally available for the purpose. If there is abundance of fluid in the subarachnoid space, it must be evacuated by pricking the membrane as it spans the sulci of the brain. No motor cortex, unless there is complete degeneration of the pyramidal tracts, fails to give response if these precautions are observed.’

Morcellement, the piecemeal removal of brain substance lying superficial to a tumour, has been recommended for the exposure and removal of cerebellar tumours, especially for such as occupy the cerebello-pontine angle. Under such conditions, *morcellement* of the outer and

[1] *Keen’s Surgery,* vol. iii, chap. xxxvi.

more superficial portion of the lateral lobe is a perfectly justifiable procedure. It is a method, however, that should never be undertaken unless considered absolutely necessary.

Extirpation of the tumour. The proportion of brain tumours which are surgically removable is small, probably not more than 20%. Even when the tumour is fully exposed, considerable experience is needed in determining whether an attempt should be made to remove the tumour or not.

If the tumour be extensive and ill-defined, no attempt should be made to remove it, the surgeon remaining content with having carried out the second desideratum with regard to intracranial tumours in general, namely, the relief of intracranial pressure with consequent alleviation of symptoms.

If, on the other hand, the tumour be circumscribed, whether meningeal, cortical, or subcortical, it may be shelled out of its bed with greater or lesser ease according to its dimensions, nature, and site. The shelling-out process is carried out with the aid of scoop or ordinary teaspoon. Rapidity of manipulation is essential. Hæmorrhage may be arrested by plugging the cavity with strips of gauze.

If highly vascular and surrounded by dilated vessels, with prospect therefore of severe hæmorrhage, the larger vessels should be underrun and ligatured on either side of the proposed line of enucleation. No attempt should be made to clamp the vessels, the fragility of the parts defeating all such measures. In some few cases, it has been found necessary to surround the tumour with a series of ligatures, perhaps interlocked, passed deeply into the substance of the brain. In cases of this nature, the greatest circumspection is needed in determining whether the local conditions warrant an attempt at removal of the tumour.

If a cyst be found, two courses are available: a small cyst may be removed entire; a large one can usually be cured by free removal of the parietal wall, and by supplying adequate drainage.

Closure of the dura and reposition of the flap. When the tumour is readily exposed, and equally readily removed, without hæmorrhage, the dural incision may be closed up, and the scalp or osteoplastic flap replaced. In most cases, however, it will be found necessary to insert a drainage tube. After exposure by craniectomy, the tube can be brought out by means of an incision through the most dependent part of the flap, whilst, in the case of craniotomy, one of the trephine holes, or other suitable part, can be utilized.

Considerable difficulty may be experienced in securing accurate approximation of the dural flap. Assistance may be obtained by elevation of the head, and by restraining the bulging cortex with 'two narrow spatulæ, passed beneath the dura. The two spatulæ are separated like a pair of scissors during the suturing process, and brought together when withdrawn ' (Bryant).

Some divergence of opinion exists with regard to those cases in which the tumour is not found, or, if found, is not capable of removal. The operation has presumably been carried out with the primary object of tumour removal, and, if such a course be impossible, the surgeon must rest content with an operation which lowers the intracranial pressure and alleviates proportionately the symptoms resulting therefrom. Under such circumstances, no attempt is made to approximate the dural flaps, the hernial protrusion of the brain being restrained by the scalp-flap and by carefully applied bandage-pressure. If the tumour has been exposed by means of an osteoplastic flap, it is usually advisable that the bone should be dissected away from the scalp in order to allow of the required lowering of intracranial pressure.

RADICAL OPERATIONS FOR CEREBELLAR TUMOURS

The cerebellum can be exposed either by craniectomy or craniotomy. It has been stated previously that the formation of the osteoplastic flap is generally contra-indicated in cerebellar operations, mainly owing to the restriction of the field of operation. Craniectomy may be regarded as the operation of choice.

The line of the scalp incision and the site of trephining are the same as when operating for a cerebellar abscess (see Chapter VI). After the removal of the disk of bone, the gap is enlarged upwards till the lateral sinus is exposed, forwards to the posterior border of the mastoid-process, downwards to the immediate neighbourhood of the foramen magnum, and inwards to near the middle line. This completes the first stage of the operation. In the treatment of cerebellar tumours, the opening of the dura and the search for the tumour should always be postponed for a few days, unless the general condition of the patient is such that immediate relief of intracranial pressure is demanded. After the completion of the first stage the scalp-flap is replaced and fixed in position with a few sutures. At the second stage, the dura is incised and turned down as a flap, the convexity of which falls short of the line of the lateral sinus. All meningeal vessels that cross the proposed line of dural section are first underrun and ligatured.

The cerebellar substance is examined by palpation, inspection, and exploration in the manner described when dealing with tumours of the cerebrum. Greater difficulty is experienced, however, when the operator has to deal with a cerebellar tumour on account of the restriction

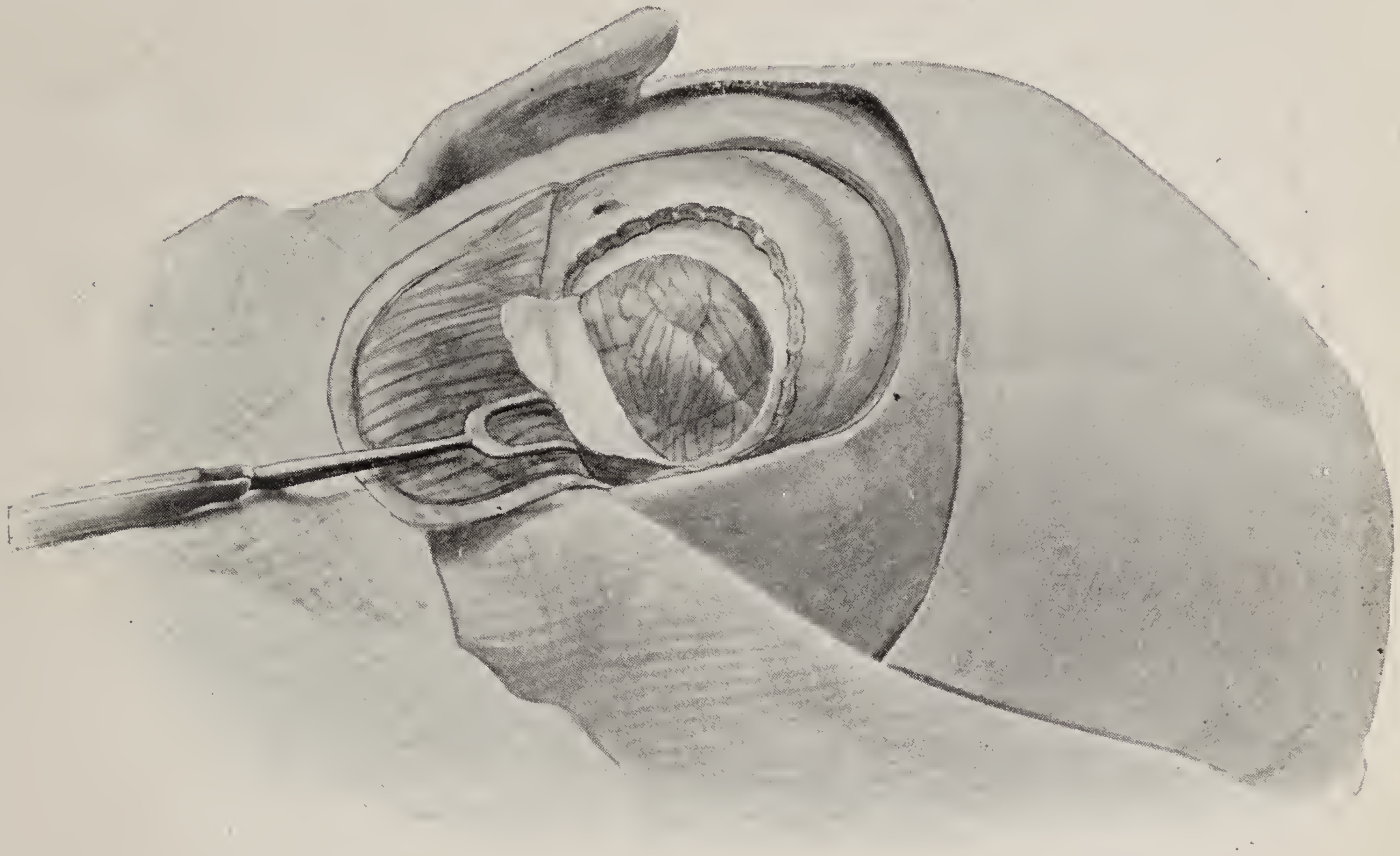

FIG. 221. UNILATERAL EXPOSURE OF THE LEFT HALF OF THE CEREBELLUM BY CRANIECTOMY. The scalp-flap has been turned down and is fully retracted. The cerebellum has been exposed by means of a crescentic dural flap.

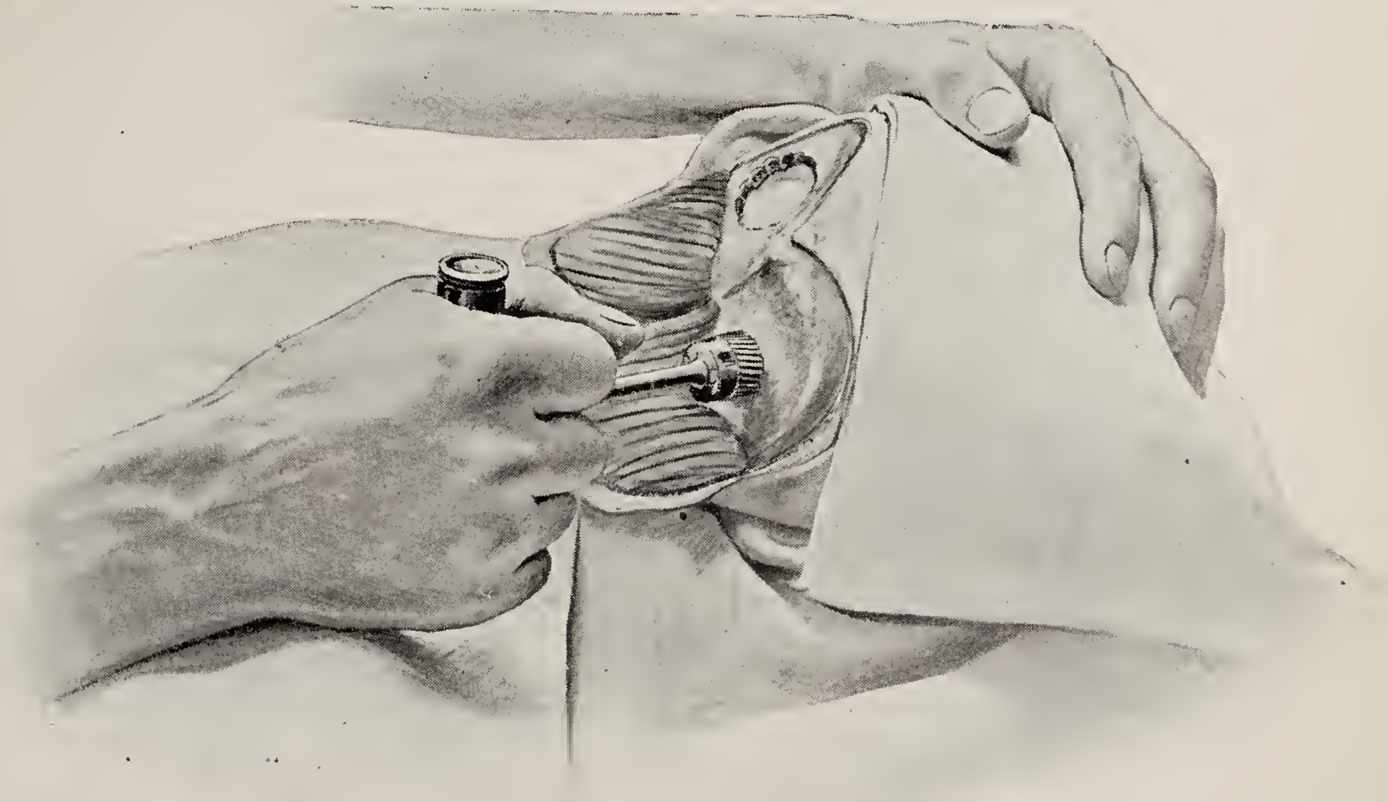

FIG. 222. BILATERAL EXPOSURE OF THE CEREBELLUM BY CRANIECTOMY. The left half of the cerebellum has been exposed. The trephine is being applied over the right cerebellar region. Note the position of the trephine and the direction in which it is being applied.

of the field of operation, the outward bulging tendency of the brain substance, and the danger of sudden respiratory failure from medullary pressure. The greatest delicacy of manipulation is required, and every precaution must be taken to avoid unnecessary damage to the soft cerebellar substance.

When the tumour is situated in the region of the cerebello-pontine angle, a somewhat favourite site for tumour formation, 'lateral displacement' of the cerebellum towards the middle line will aid in the exposure thereof. A flat retractor, bent to the suitable curve, is introduced between the dura and the cerebellum, and the lateral lobe of the cerebellum gently and gradually retracted towards the middle line. As the brain yields to the pressure, the tip of the retractor is insinuated forwards towards the posterior surface of the petrous bone. By careful retraction, gentle manipulation, and with the aid of a head-lamp, a view may occasionally be obtained of the lateral aspect of the cerebellum and of the cerebello-pontine angle. Tumours in this region are usually attached by means of a narrow pedicle to the stalk of the fifth, seventh, or eighth pair of nerves. They can usually be removed from their attachment and bed with suitable blunt instruments. The main difficulty

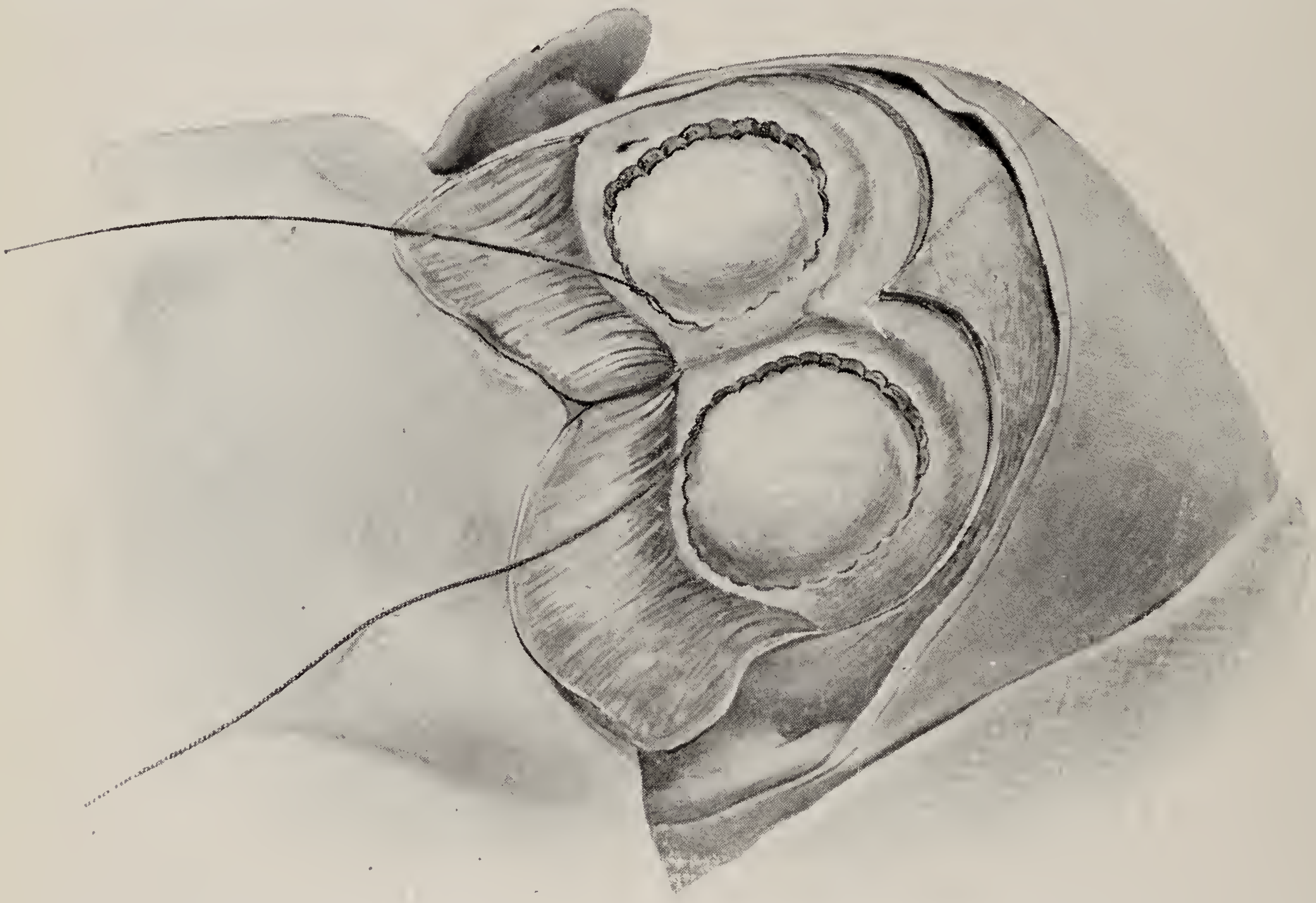

FIG. 223. BILATERAL EXPOSURE OF THE CEREBELLUM BY CRANIECTOMY. The walls of both cerebellar fossæ have been cut away, exposing the bulging dura mater. The Gigli saw is in position for removal of the bridge of bone intervening between the two cerebellar fossæ.

arises in attempting the complete removal of the tumour from the subtentorial space, this being especially the case when the operator has to deal with a tumour of considerable size. No force should be used, and in some cases it may become necessary to remove the tumour piecemeal. The removal of such tumours may be facilitated by the exposure of both lobes of the cerebellum.

The exposure of both cerebellar hemispheres. This operation may be carried out after the manner recommended by Frazier.[1] Each cerebellar fossa is exposed in turn, the scalp-flap being framed, and the trephining and cutting away of the bone carried out in the manner previously described for unilateral exposure. The osseous bridge which separates the two openings in the skull is divided above and below with Gigli's saw, and the intermediate part removed. This completes the first stage of the operation (see Fig. 223).

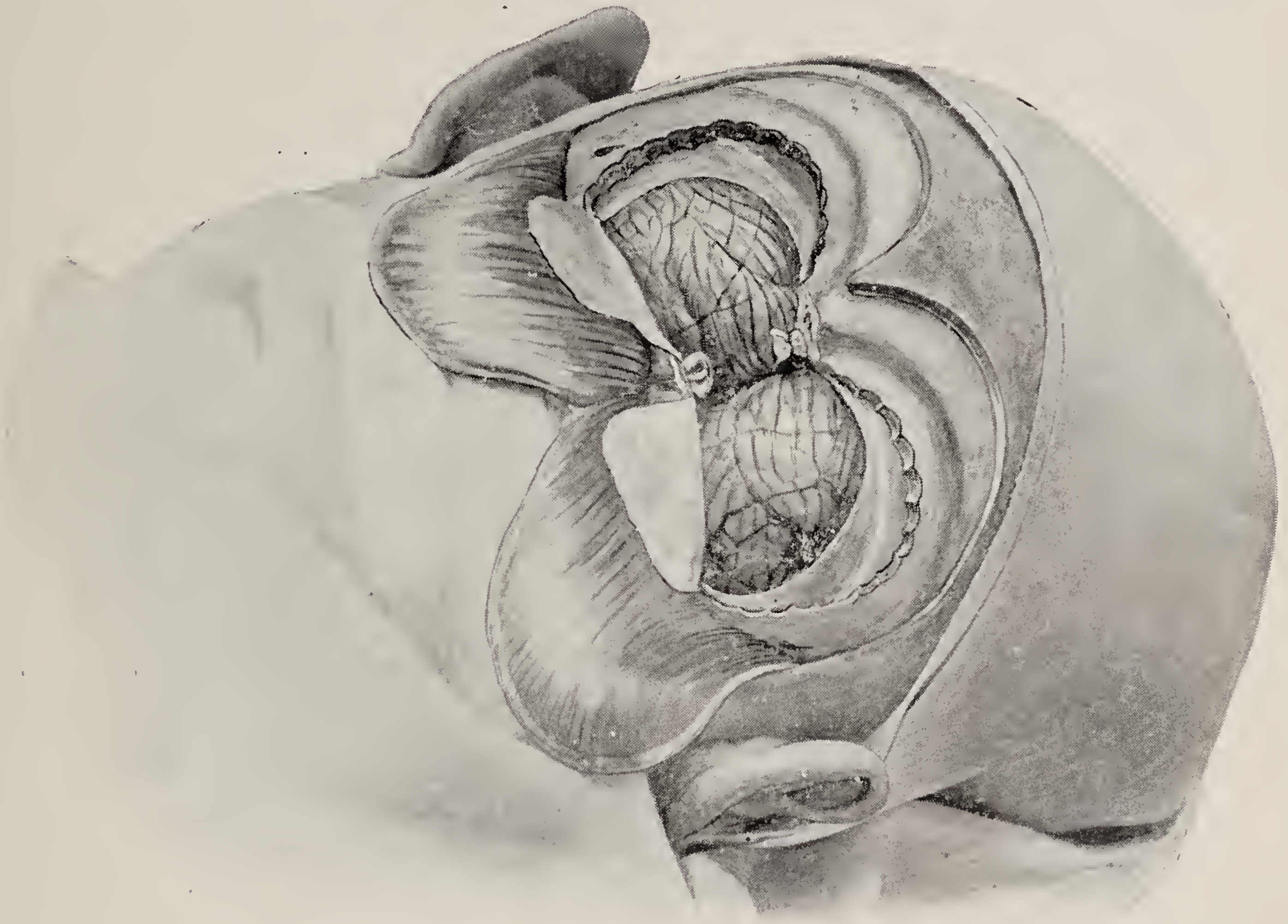

FIG. 224. BILATERAL EXPOSURE OF THE CEREBELLUM BY CRANIECTOMY. The bridge of bone has been removed, two crescentic flaps of dura mater have been turned down, and the falx cerebelli has been ligatured in two places and divided.

After the lapse of a few days, the scalp-flaps are again turned down, and dural flaps framed on either side of the middle line, avoiding the lateral sinus above and the occipital sinus in the middle line. The occipital sinus is ligatured above and below by means of an aneurysm needle, threaded with catgut, passed around or through the falx cerebelli. The falx is then divided between the ligatures.

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[1] *New York Med. Journ.*, February, 1905.

The details of the operation are simple to describe. In practice, the difficulties are great, the hæmorrhage severe, and the degree of shock proportionate. The extra space afforded not only allows of the exposure of both halves of the cerebellum, but also permits of the 'dislocation' of one lateral lobe towards the opposite side, thus facilitating the examination of the lateral aspect of the cerebellum and the cerebellopontine angle.

PALLIATIVE OPERATIONS FOR CEREBRAL AND CEREBELLAR TUMOURS

All palliative operations carried out merely with the object of procuring symptomatic relief may be conducted over the region of the tumour, or over one of the so-called 'silent areas' of the brain, *e.g.* the temporo-sphenoidal lobe. It is obvious that the greatest degree of reduction of intracranial pressure can be obtained by craniectomy, performed over the region of the tumour itself. To this course, however, there are certain exceptions. The precentral or motor area should always be avoided, if possible, for any marked degree of hernial protrusion of this portion of the brain must necessarily result in paralysis, spasticity, &c. In the case of cerebellar tumours also, the subtentorial pressure can undoubtedly be relieved in the most efficient manner by a cerebellar operation, the bone being freely cut away, the dura incised up to the margins of the osseous deficiency, and the cutaneo-muscular flap replaced accurately and firmly in position. This operation presents, however, a great disadvantage, in that the hernial protrusion is often excessive, with disastrous results on the medullary centres.

In the event of the surgeon deciding to attempt alleviation of symptoms by trephining over one of the 'silent areas' of the brain, the operation of choice is that described by Cushing as 'intermusculo-temporal cerebral decompression.' The details and advantages of the operation have already been discussed (see p. 392). When carried out for the relief of pressure resulting from an irremovable brain-tumour, the operative details previously described should be closely adhered to, with the following important exceptions:—

(*a*) After the dura has been incised, no attempt should be made to explore the apex of the temporo-sphenoidal lobe.

(*b*) No drainage tube is inserted, the dural flaps being allowed to lie loosely over the surface of the brain, so allowing of hernial protrusion.

(*c*) The temporal muscle and fascia are sewn up with extra care, thus limiting the degree of hernial protrusion.

With regard to the side on which the operation is to be carried out, it appears that the best results are obtained when the operation is conducted on the same side as that on which the tumour is situated. In the event of failure to procure satisfactory results, a similar operation may be carried out on the opposite side of the head.

PUNCTURE OF THE CORPUS CALLOSUM

This procedure carried out for diagnostic and therapeutic purposes is a measure of considerable value in some cases. It has been used most often in hydrocephalus, hypophyseal, cerebellar, and other tumours in the ventricles. The principle upon which it is supposed to act is this. In such cases where the pressure is high if an opening be made through the corpus callosum into the subarachnoid space between the hemispheres, the intraventricular pressure will tend to keep the opening patent and thus provide a permanent intraventricular drainage into a space where absorption of the secreted fluid is freer than in the ventricle. While the beneficial results in the hands of Kanavel have not been as brilliant as Anton and others have reported, a moderate use of the procedure has convinced him that in certain cases we may expect great relief from pressure symptoms, and in a few cases a symptomatic cure. There is very little danger to the procedure. Veins may be injured, leading to troublesome hæmorrhages, or too deep puncture may injure the optic thalamus with temporary impairment. This is especially to be feared in basal tumours distorting the ventricle. No bad result has occurred in Kanavel's experience except that in one patient there was a temporary paralysis of the arm, whether due to too deep puncture or to a change in pressure of the unlocalized tumour was not known.

Technique. If the patient is not nervous the operation may be performed under local anæsthesia. In such cases it is Kanavel's custom to give, unless contra-indicated, a preliminary dose of scopolamine 1/200 gr. and morphine 1/8 gr. two hours and one hour respectively before the operation. The area being infiltrated, a longitudinal incision is made running backward from the coronal suture and parallel to the longitudinal suture. The skin and the aponeurosis of the occipito frontalis are retracted by the ordinary mastoid retractor. A trephine now removes a button of bone, the centre of which is about 2 cm. from the coronal suture and the same distance from the longitudinal. A slit is made in a non-vascular part of the dura which is retracted with fine retractors. A needle is chosen that has a bulbous blunt end, with holes at the end and side. The needle should be flexible, with a stylette, and should be at least 10 cm. long. The needle is bent at an angle of about 90°, approximately 6 cm. from the end, since this is the average distance from the surface of the brain to the ventricle. A few small veins pass from the cortex veins to the longitudinal sinus and in most cases there is a slight adhesion of the cortex to the longitudinal sinus. The needle is gently passed through this and rotated downward along the falx cerebri (see Fig. 225). A slight resistance

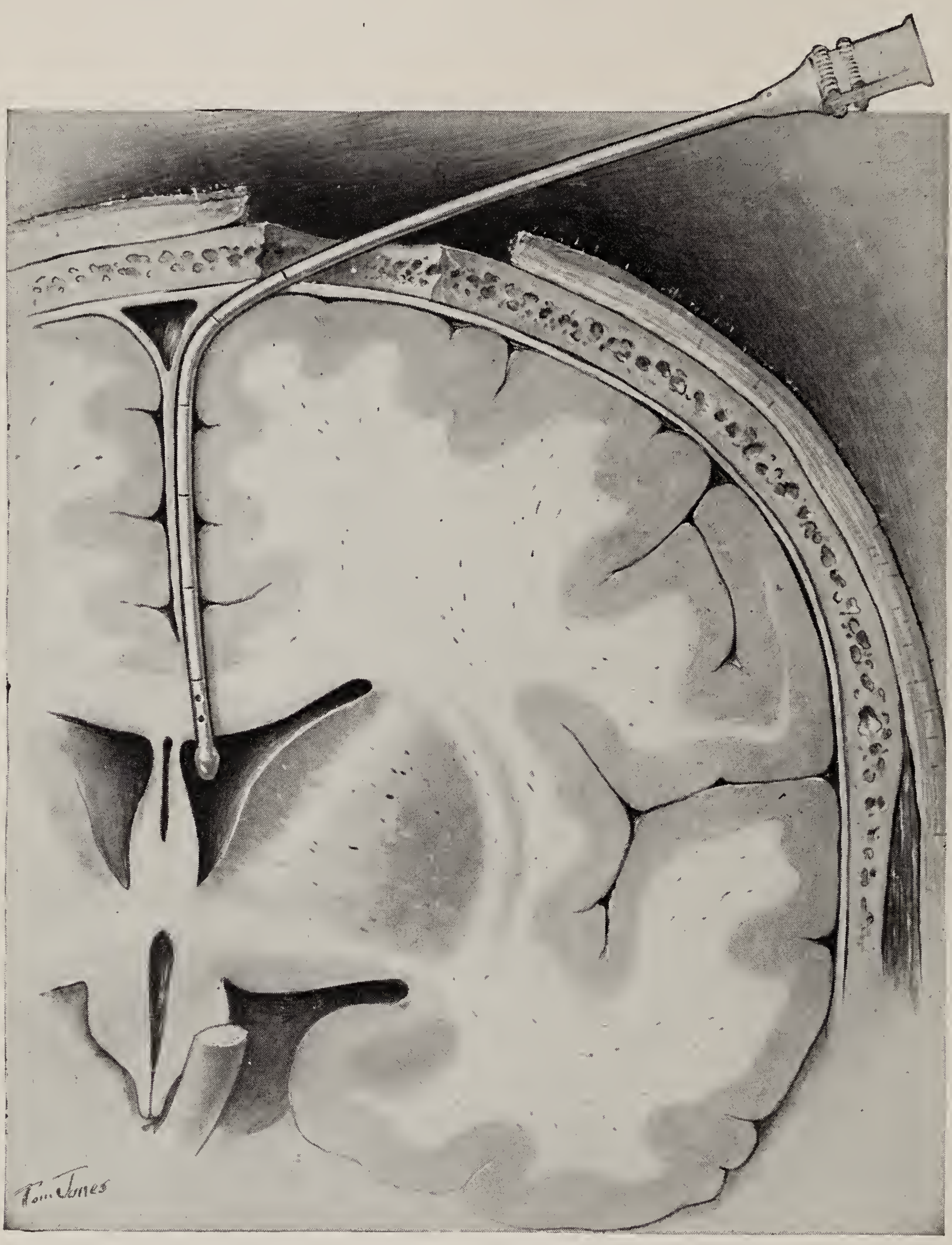

FIG. 225. TECHNIQUE OF CORPUS CALLOSUM PUNCTURE. (*Kanavel.*)

is felt when the corpus callosum is reached. Here the end is gently moved back and forth to avoid penetrating the pial vessels and then is thrust through the corpus and the stylette removed. If tension is present, the fluid flows out freely. The needle end is rotated backward and forward for about a centimetre to tear the corpus callosum and then it is withdrawn. Elsberg says that it is easy to make the mistake of going too far forward. The dura is closed, bone plug replaced or not as desired, and the wound closed.

CHAPTER VIII

SURGERY OF THE HYPOPHYSIS

By Allen B. Kanavel, A.B., F.A.C.S., Lieutenant-Colonel, U.S.A.

Indications for operation. The indications for operation in cases of hypophyseal disease may be classified as absolute and relative. Operation is absolutely indicated in those cases in which the tumour immediately jeopardizes the life of the individual or is causing progressive blindness. It is relatively demanded when, because of perverted or increased or decreased secretion, the well-being and ultimately the life of the individual is threatened. Therefore, if the tumour is growing rapidly or has grown to a large size, or if a cyst has suddenly filled, we will have pressure symptoms both locally and generally that will imperatively demand intervention. As the safety of the operation increases the field of the relative demand will be broadened.

Just how far this will extend cannot be fully stated now, when our knowledge of the perverted states is limited. Thanks to the magnificent and painstaking work of Cushing, we have a basis at least upon which study may be made.

Cysts offer from a surgical standpoint the most satisfactory type of tumours of the hypophysis. Not only is the operation technically more simple, but from a prognostic standpoint the results are superior to those we have been able to secure in the adenomata and other solid tumours, in that the patients are restored to society as useful and self-sustaining members who may live out the natural span of life. This latter desideratum, which should be the end and aim of all surgery, has not always been demanded in cranial surgery. We too often announce operations as successful in patients who secure comparative physical well-being, but who nevertheless remain charges on their relatives or public charity. The patients with hypophyseal cysts, on the contrary, recover both physical and mental properties but unfortunately do fail frequently to recover certain physiological functions, in that the sexual phenomena and the processes of growth are commonly lost. One cannot but hope, however, that as knowledge concerning these cases becomes widespread, we may be able to operate upon them earlier in life. It would seem reasonable to assume that if the cyst be treated before puberty, these physiological functions may be preserved either through normal hypertrophy of the portion of the gland remaining or through the interrelation of the other ductless glands taking on its function.

Although we must admit that the function of the anterior and posterior lobes and the pars intermedia has not been settled beyond question, yet the magnificent work of Cushing, Goetsch, and their associates, Lewis and a host of other able workers, has in general ascribed growth to the anterior lobe, while the change in kidney function, adiposity, &c., reside in the pars intermedia or the posterior lobe. Erdheim deserves great credit for bringing forcibly to our attention the fact that these cysts generally have their origin in the anterior lobe or *anlage* of the primitive pharyngeal pouch. If these observations be true, we would expect impairment of growth both from cellular destruction and cellular physiological perversion due to pressure, the latter naturally being subject to recovery upon removal of the pressure due to the cyst. In like manner, a recovery of the function of the pars intermedia and posterior lobe becomes possible. To secure the greatest benefit, therefore, it is necessary that the tumour should be removed before the onset of puberty with its probable cellular hypertrophy and certain physiological activity. Unfortunately, our knowledge of the signs and symptoms of the disease is confined to the evidences of long-continued perversion of function as well as primary destruction. We now recognize the disease by the picture presented some years after puberty, just as for many years we recognized thyreoid perversion by the ultimate exophthalmic sign, myocarditis and enlarged thyreoid, not by the toxic evidences of bruit over the gland, vasomotor instability and tachycardia which we now know precede the other evidences by many months and indeed can be prevented by early operation. So may we not hope that careful analysis of the histories given by these patients and careful observation on the part of each of us may elicit some symptom-complex suggestive enough at least to demand X-ray studies of the sella turcica, and through this lead to diagnosis? The development of symptoms about the time of puberty may be due to two factors: first, the onset of the physiological processes above mentioned, and second, the changes in the cyst itself incident to secretory changes at this time of life. That the latter has considerable bearing on the case seems probable when we remember that in addition to the perversions of physiological processes noted in these glands, the evidence of brain pressure begins to be marked, a sign seldom seen before puberty. The cysts probably grow from two causes: increase of fluid—either by secretion from its wall or filtration from compressed veins—and from hæmorrhage into the cyst. The latter is by no means an uncommon occurrence. In view of these general observations, it follows that at puberty any child showing an absence of growth, particularly if he has attacks of transitory blindness, should be studied immediately for hypophyseal disease. Attacks of transitory blindness are noted in most of the histories of these cases. Many have rested for years under the diagnosis of hysteria made by able ophthalmologists. Whether these periods of blindness are due to hæmorrhage into the cyst with subsequent absorption, is open to question, but that it frequently is the cause is my personal belief.

Acromegaly should be treated most conservatively, particularly since many of the cases have passed over into the stage of hypopituitarism. As the safety of the surgical procedures grows, operation should be attempted in the early stages of the disease, before the growth has left the sella. The more complicated and late cases and those with atypical signs should be treated medically until the results in the typical cases are well established.

Operative procedures. Operative procedures in hypophyseal tumours and cysts may be classified as palliative and curative. As our knowledge increases, a greater per cent. will fall into the latter class than can now be placed there.

The routes of approach may be classified as:—

A. Intracranial—
  1. Through the middle fossa.
  2. Through the anterior fossa.

B. Trans-sphenoidal—
  1. Through the nose.
    (*a*) Supranasal.
    (*b*) Infranasal.
  2. Through the mouth.
    (*a*) Through the palate.
    (*b*) Behind the palate.

The intracranial route. Through the middle fossa. This route was originally suggested by Caton and Paul, and has been used by Horsley in all his cases. Dalgren, Cushing, and others have attempted to follow the same route. It is certainly much more difficult and less satisfactory than the approach through the frontal region.

Through the anterior fossa. Killian first suggested this route and proposed making a bone and dural flap followed by elevation of the frontal lobe. At the present time, however, the extradural route suggested by Krause, appears better. This has been used successfully by Bogoiavlensky, but did not meet with favour until McArthur proposed removing the orbital ridge in addition. This suggestion is a landmark in hypophyseal surgery. Frazier modified the suggestion slightly, and Elsberg by adding that the flap should be made with its base inward and that the orbital ridge should be left attached to the frontal bone, has made the approach nearly ideal for those cases in which the intracranial operation is chosen. Elsberg's technique is described by himself as follows:

'X-rays having been taken to determine the size and extent of the frontal sinuses, the side of the frontal bone is selected in which the sinus is the smallest. If the patient has lost the sight of one eye, it is best to do the operation on that side.

'An incision is made from the inner angle of the eyebrow outward to the external angular process of the frontal bone, then upward and backward to within the hair line and then inward to near the median line. With an ordinary trephine, openings are made at the beginning of the incision, just above the external angular process and at the upper outer and upper inner angles of the incision in the soft parts. The bone is cut in the usual manner with Hudson forceps. The soft parts are slightly dissected down from the supra-orbital ridge, the roof of the orbit about 1 cm. behind the supra-orbital ridge divided by slight blows from a small chisel, the supra-orbital ridge cut at each trephine opening with a Gigli saw or sharp Liston forceps, and the bone fractured toward the median line. On account of the thickness of the bone in the median line, it is usually necessary to partly divide the base of the bone flap with the cranial forceps (see Fig. 226).

'With various rongeurs, the thin roof of the orbit is removed down to the optic foramen, care being taken that the direction of the rongeuring is correct so as not to open into the ethmoid sinuses, and that the periosteum of the orbit is not injured. As the operator approaches the optic foramen, a long-bladed rongeur must be used, the orbital contents depressed, and the frontal lobe in its dura slightly elevated. As soon as the optic foramen is reached, and after all oozing of blood has been controlled by gauze pressure, an incision about 3 cm. long is made from the exposed anterior clinoid process toward the median line, a small brain retractor introduced into the opening and the frontal lobe elevated. The optic chiasm, hypophysis, and sella turcica are now in good view.

'When the treatment of the hypophyseal lesion has been finished, the bone flap is returned into place and the soft parts sutured in the usual manner.

'The operation is not at all difficult in the hands of the surgeon experienced in cranial surgery, and an excellent exposure of the region of the hypophysis is obtained. It is possible to extirpate or partially remove a growth from around the pituitary body in full view, and the operation is surgically very satisfactory. The amount of elevation of the frontal bone that is necessary is not very great, so that no injury to the brain should occur. The orbital roof should be removed over an area about 2 cm. in width, and if an ethmoid sinus be opened it should be closed with a little Horsley wax. The supra-orbital ridge forms part of the osteoplastic flap, which is better than if the bone is removed in one piece and later replaced, as in Frazier's operation. The amount of visible scar is very small, only a small line between the external angular process of the frontal bone and the hair line.'

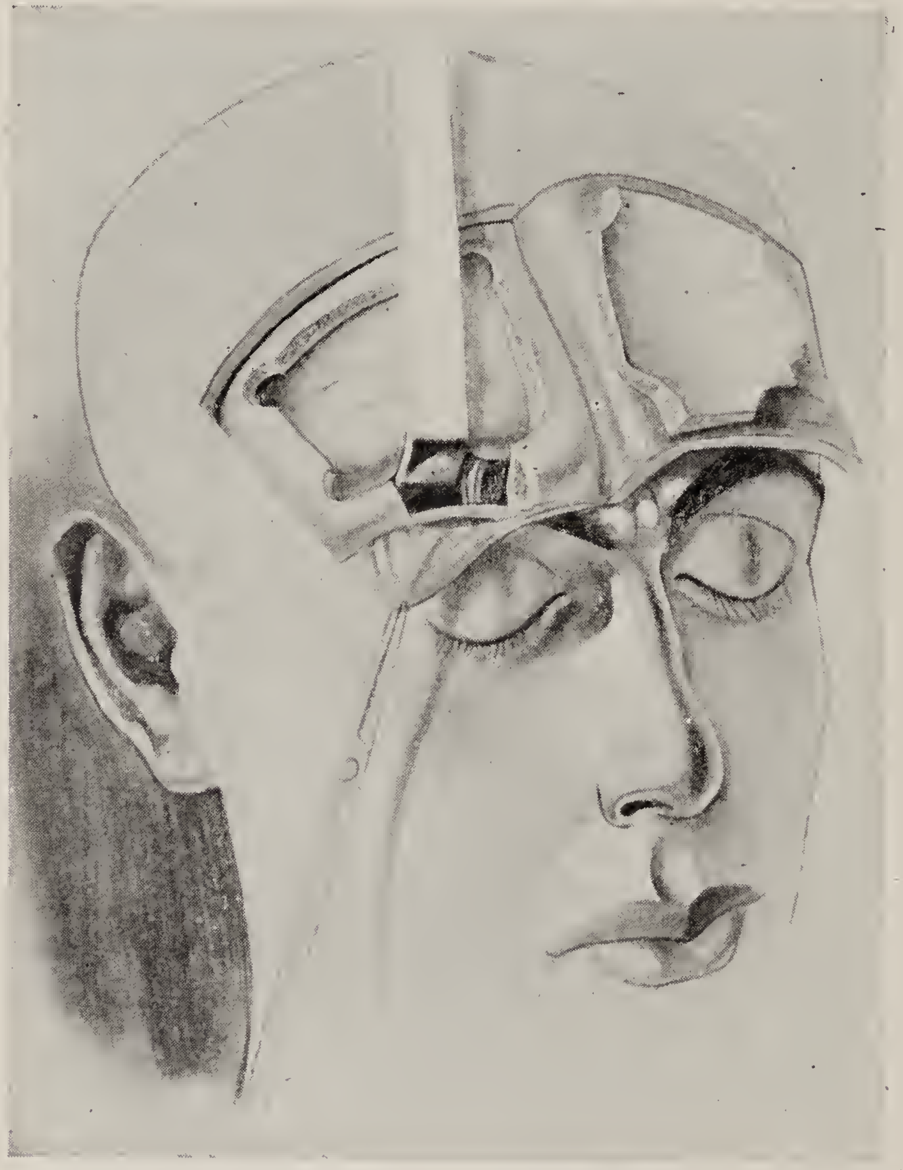

FIG. 226. TECHNIQUE OF ELSBERG APPROACH.

Trans-sphenoidal methods. Supranasal route. Schloffer first used this method. He turned the nose to the right, excised the turbinate, the ethmoid cells, and the septum, removed the inner wall of the left orbit down to the orbit foramen and the inner wall of the antrum of Highmore with a portion of the nasal projection of the left superior maxilla, and then reached the tumour through the sphenoidal sinus. Hochenegg, Moskowicz, and Tandler, Chiari, Michel, Giordano, and others have modified the procedure. Of all these modifications that of von Eiselsberg is most popular. His technique is as follows:

Three days before the operation the patient receives 2 gm. urotropin daily. The coagulability of the blood is determined and calcium lactate given if it is delayed. The nose and throat are carefully examined. Anæsthesia with morphine and ether or Billroth's mixture. The operative field is sprayed with ½% novocain (H. Braun) to stop hæmorrhage. Tamponade is accomplished by Bellocque's method. The incision is made along the left naso-labial groove up to the glabella, over the bridge of the nose to the right palpebral fissure. The nasal bone is cut through with hammer and chisel. The philtrum nasi is cut at its juncture with the upper lip. A large portion of the septum and vomer is detached with the nasal flap. The remains of the septum, vomer, rostrum, and the turbinates are next removed.

Hæmorrhage is stopped with adrenalin and compression. The sphenoid sinus is now opened, its anterior and inferior walls removed and the cavity scraped out. The hypophyseal tumour is usually exposed at this stage, the dura is incised, and as much of the tumour as is thought advisable is removed with a sharp spoon (excochleation). After stopping hæmorrhage, a cigarette drain is placed in the defect and fastened by a stitch around the left nostril. No tamponade is necessary. Finally the nasal cavity is cleaned out, Bellocque's tampon is removed, and the nasal flap sutured in its place.

Infranasal route. Owing to the danger of meningitis from exposing the cribriform plate and for the purpose of simplifying the procedure, it was suggested by the author that the sphenoid should be approached through the inferior portion of the nose, thus avoiding the removal of the ethmoid. In his hands the operation has been most satisfactory. The procedure as originally proposed has been modified in that a submucous resection of the septum is done, following the suggestion of Hirsch, which is certainly a distinct advantage. Halstead and Cushing have since followed the same route with some modifications in technique. Instead of incising in the nasolateral fold, Halstead raises the lip and makes his incision in the labiobuccal fold. He has operated with brilliant success by this method. The author has used both the method to be described and the Elsberg method and believes that certain cases should be operated upon by the infranasal method and others by the transfrontal.

The infranasal technique follows:

The nose is packed with strips of adrenalin gauze to lessen the bleeding. The patient is placed in a semi-sitting position so that the blood will not accumulate in the sphenoid sinus and over the field of operation (see Fig. 227). A tight posterior nasal gauze plug is inserted. This is not so much necessary to prevent blood entering the pharynx, since, if the operation is done properly, there should be no tear in the mucous membrane, but it does prevent air escaping through the nares during the bone operation. An incision of the skin down to the bone is now made in the crease close under the nares and the alæ of the nose (see Fig. 228). The nasal spine is cut and with the greatest

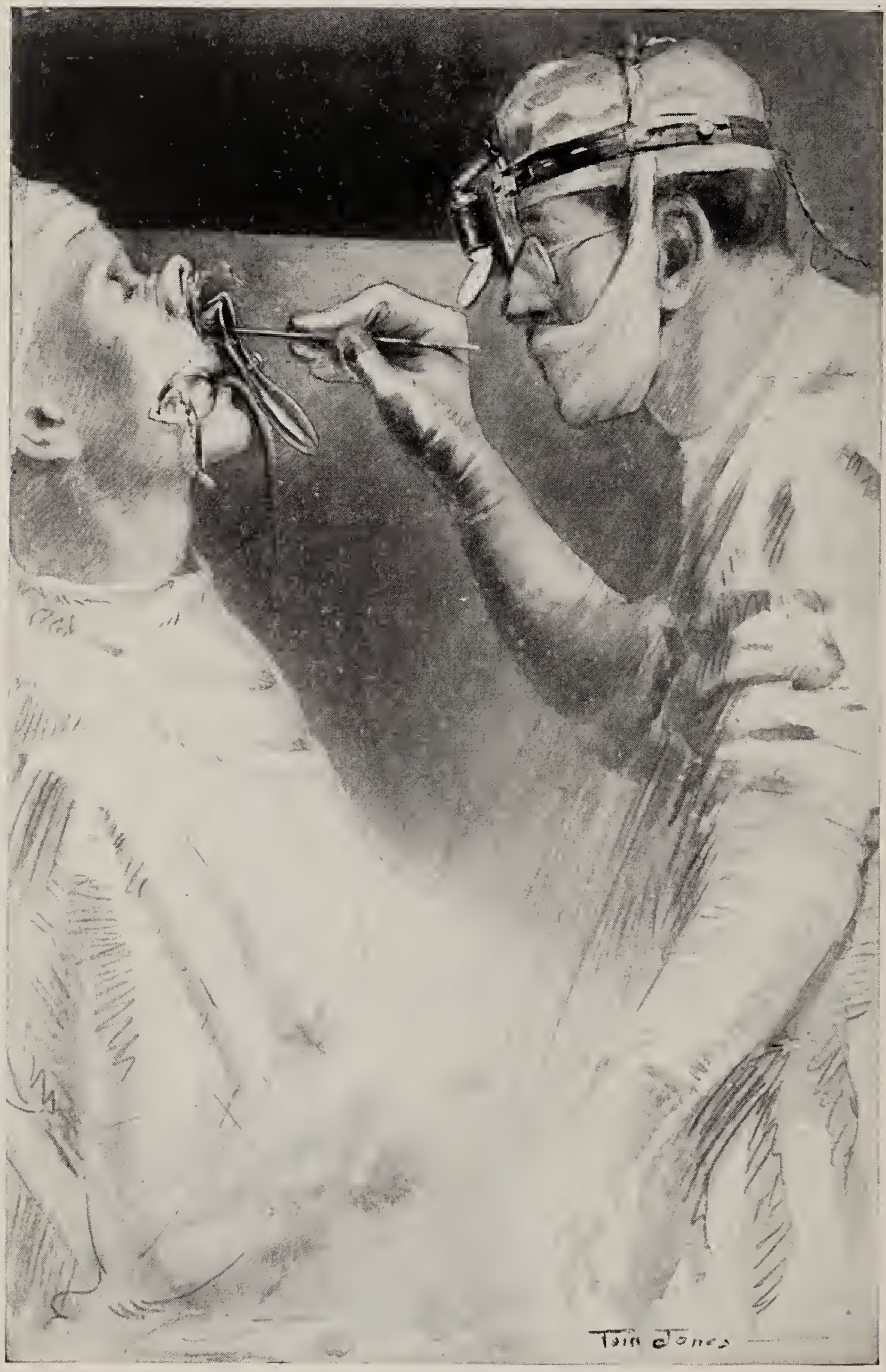

Fig. 227. Position of Patient for Hypophysis Operation. (*Kanavel.*)

of care the mucous membrane is raised from the floor of the nose and off of the septum, back to the sphenoid bone, and off from the front of this bone (see Fig. 229). The septum and the anterior wall of the sphenoid sinus is now removed, followed by removal of the posterior wall, *i.e.* the anterior wall of the sella turcica (see Fig. 230). This is best entered by a chisel and the bone removed by a punch forceps (see Fig. 231). The dural covering now being cut, the soft tumour mass appears and may be curetted away. If a cyst is found, its walls should be gently curetted and in my experience should be lightly packed with gauze saturated with a weak iodine solution to favour obliteration of the sac or preserve an opening into the sphenoid. If a solid tumour is removed, no drainage is necessary if the bleeding is well controlled. The mucous walls of the removed septum are allowed to fall together, a subdermal stitch closes the skin wound, the nares are packed lightly

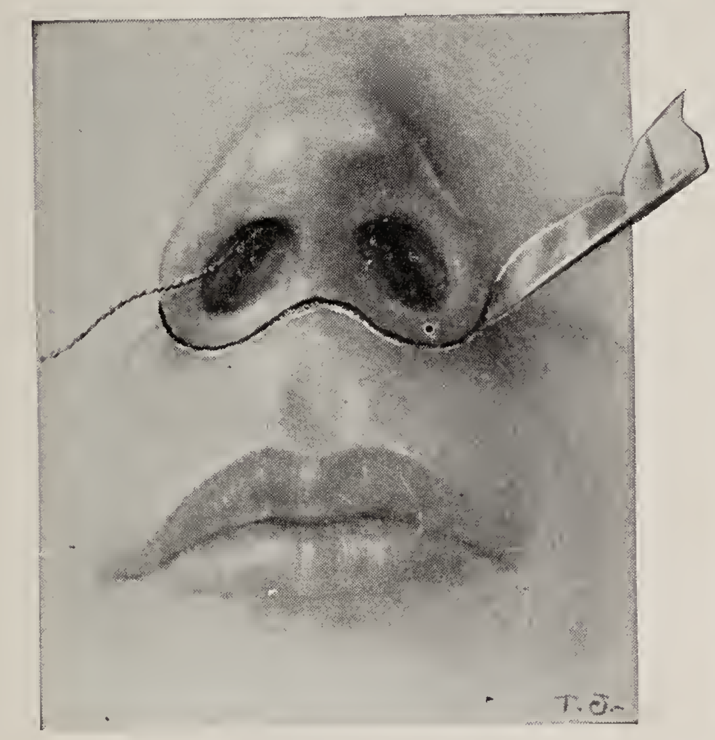

FIG. 228. LINE OF INCISION. A string is attached to posterior nasal plug. (*Kanavel.*)

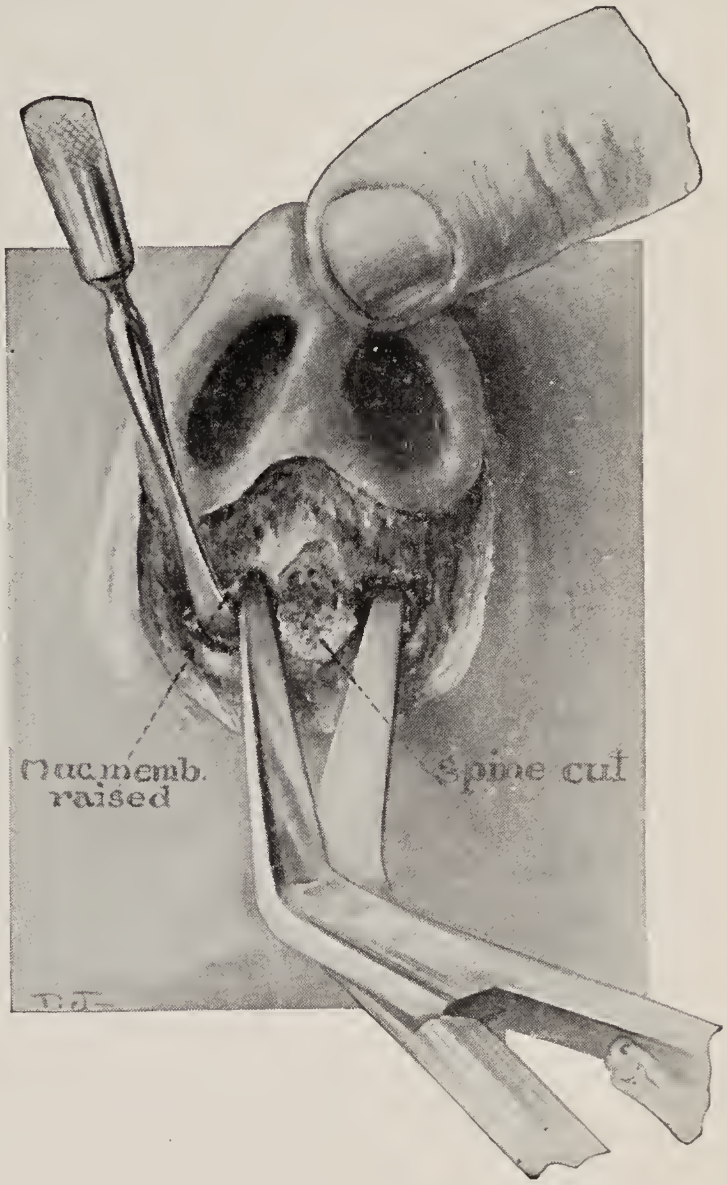

FIG. 229. THE MUCOUS MEMBRANE IS RAISED FROM THE FLOOR OF THE NOSE AND THE SEPTUM. The bony spine is being cut. (*Kanavel.*)

with bismuth subnitrate saturated gauze, the posterior nasal plug is removed, and the patient returned to bed (see Fig. 232).

The anæsthetic is best given through intratracheal insufflation, or a pharyngeal tube, although the author has used rectal anæsthesia with satisfaction.

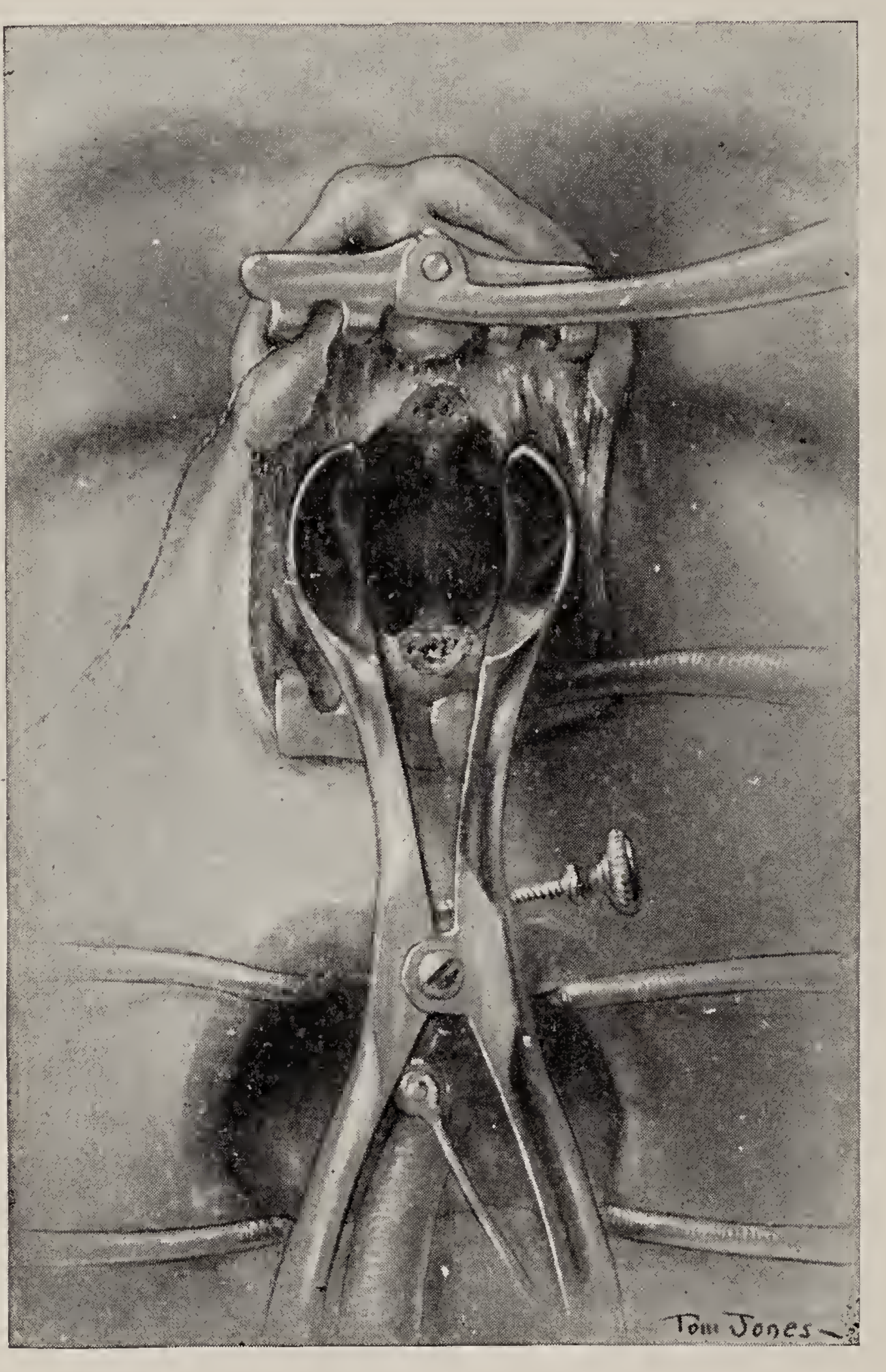

Fig. 230. The Mucous Membrane has been pushed to the Side by the Speculum and the Septum removed. The speculum is long and has a set-screw attached which holds it in position. (*Kanavel.*)

The operator should be familiar with the anatomy of the interior of the nose and especially the sphenoid sinus, and the relations of the sella turcica. He should provide himself with proper instruments and an excellent headlight. No matter what method of approach is used, the operation is difficult and should be undertaken only after thorough preparation.

Care should be taken not to operate during an acute rhinitis and the author has in those cases where he feared the possibility of infection given 50 c.c. of antistreptococcus serum the day before operation.

The greatest difficulty is met with in separating the mucous membrane from the septum at the beginning of the procedure at the external nares. Especial care should be exercised here not to rupture the membrane. At the time of pushing the membrane off from the anterior wall of the sphenoid one may be careless and again tear the tissue.

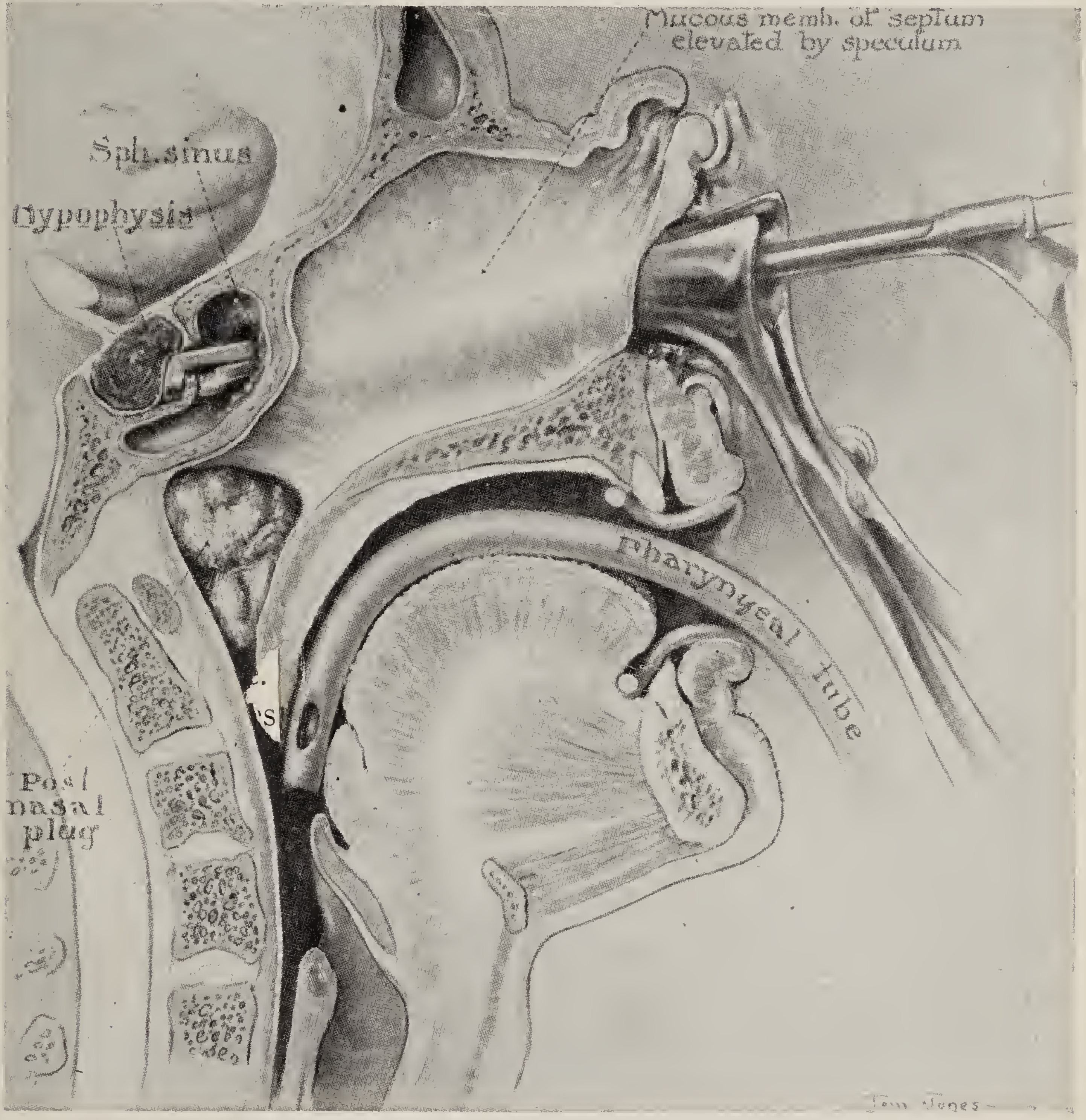

Fig. 231. Hypophysectomy. (*Kanavel.*)

Especial care should be used to orientate oneself before entering the sphenoid cells, since it is very easy to break through the base of the skull and enter the medulla. In 13 out of 120 skulls examined the bone plate was so thin at this site that light could be seen through the dried bone. Again one may enter the anterior ethmoid cells under the mistaken idea that it is the sphenoid. The former mistake is, however, much more likely and is especially to be guarded against. After entering the sella one may satisfy himself as to his location by passing the probe along the floor of the sella. In case of doubt it is wiser to pack the area with gauze saturated with bismuth and take X-ray pictures, finishing the operation at a second sitting. A small wire may also be incorporated in the gauze, lying at the uppermost point reached.

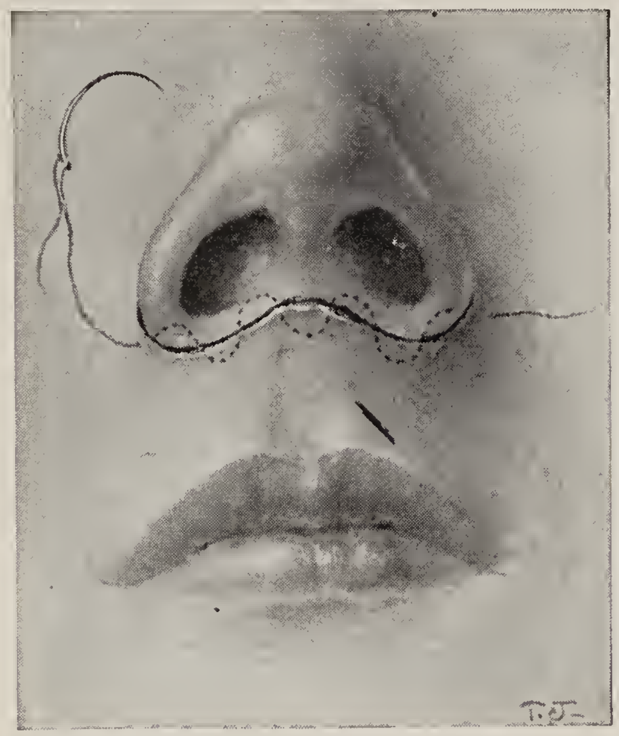

Fig. 232. Shows the wound closed with Subcutaneous Stitch. No scar is visible. (*Kanavel.*)

Hirsch has operated under local anæsthesia with remarkable results. His technique is as follows (*Keen's Surgery,* vol. vi, p. 304):

In his earlier cases he removed the inferior and middle turbinates at the first sitting; at the second, the anterior and posterior ethmoids; at the third, the anterior wall of the sphenoid with the impinging septum; and at the fourth, the anterior wall of the sella turcica. The tumour was then removed by a curette. Later he suggested the submucous route, and urged it as a means of lessening the dangers of infection. He has described his technique as follows:

'The mucous membrane of both sides of the nasal septum is desensitized with a 20% cocaine solution. An incision is now made along the anterior edge of the quadrangular cartilage, through the mucous membrane on one side, down to the cartilage, and the mucous membrane is raised by means of a raspatorium, together with the perichondrium and periosteum, from the cartilage and bone. The cartilage is now incised ½ cm. from the original incision and a raspatorium slipped between the perichondrium and the cartilage and carried to the posterior border of the septum; the mucous membrane, together with the perichondrium and periosteum, are now raised from cartilage and bone on this side. The membranes are now held apart by a nasal speculum and in this way a medial nasal cavity formed in which one sees the bare cartilage. This is removed with one sweep of the cartilage knife, and the vomer and the perpendicular plate of the ethmoid are resected with the aid of a bone forceps. Up to the present this operation is identical with Killian's submucous septum-resection.

'To bare the wall of the sphenoidal cavity it is necessary that the mucous membrane of the vomer where it joins the sphenoid be separated from the bone. This is very easily done, after which the mucous membrane is separated from the anterior surface of the sphenoid on both sides as far as the ostium sphenoidale, so that the raspatorium falls into the sphenoidal cavity. Now through this sac of mucous membrane one removes the posterior part of the vomer and the rostrum sphenoidale, with the bone forceps, and with several strokes of a chisel one breaks through the anterior wall of the sphenoid cavity, and after removing the sphenoidal septum one sees the hypophyseal prominence in its entirety.

'After opening the sella turcica and the dura of the hypophysis respectively the hypophyseal tumour lies free in the sphenoidal cavity.'

Approach through the mouth. Various other procedures, such as resection of the superior maxilla by various methods, entrance through the antrum of Highmore, by splitting the palate, going behind the palate after an incision between the lower jaw and the tongue, &c., have been suggested, none of which has found favour with those surgeons dealing frequently with these tumours.

Choice of operation: intracranial versus trans-sphenoidal. At the present time one cannot say definitely which procedure will be the one of choice. Certain general principles can be laid down, however, and the lines of future work suggested.

The trans-sphenoidal route cannot, unfortunately, be rendered absolutely aseptic, and, therefore, meningitis is always a possibility, although that menace is growing less as our experience accumulates. This route is not available for tumours lying in juxtaposition to the hypophysis and hence giving hypophyseal symptoms. Moreover, one cannot remove all the tumour when it has extended widely outside the sella turcica.

The intracranial route is not advisable for tumours confined to the sella turcica. It can be only palliative in a majority of cases, since it does not become the operation of choice until the tumour is far advanced, and in most cases it will be impossible to remove the part of the tumour lying in the sella turcica. Therefore, we may say that tumours lying for the most part in the sella turcica should be reached by the infranasal route.

Cysts may be reached and drained by either route, but more permanent results may be hoped for from the trans-sphenoidal route since this affords room to grow and makes subsequent puncture and drainage easy.

Tumours that have surely grown beyond the sella turcica can be reached by the intracranial route. Neighbourhood tumours may be reached in the same manner.

In this connexion it should be remembered that the trans-sphenoidal route gives a decompression opening, in case of future growth, for the local structures as well as for the brain; while the intracranial in the majority of cases gives relief for general brain pressure only.

Prognosis. The mortality in the past has been in the neighbourhood of 35%, and will probably so continue in the hands of those doing little cranial surgery. The reports of Cushing and Hirsch now show an average of 10%. The author has operated 15 times with 4 deaths, all but one of these in his earlier cases.

Prognosis as to ultimate results. What, in various types of disease, may be looked for as the ultimate result? While it is too early to prognosticate this, a review of the literature as well as our experience would seem to indicate the following:

Cysts may be operated upon with particularly good results as to local pressure. That they may recur the experience of Horsley demonstrates. That they often do not is proved by my experience in the case reported, as well as in the cases of von Eiselsberg, who reports two cases well two years after the operation. Hirsch has operated upon five cysts and states that they have good chances for amelioration of symptoms. The eye signs have been uniformly bettered, unless complete nerve atrophy was present. The excessive adiposity has generally been lessened if the operative procedures have been supplemented by whole gland feeding. The sexual development has been little affected, although von Eiselsberg reports slight change in one case. Marked change in growth has not as yet been produced, even with gland feeding. The growth of hair and a tendency to change from the female to the male type has followed frequently if gland feeding was instituted.

Owing to the fact that acute pressure symptoms in these cases are due often to hæmorrhage into a cyst, an absolutely bad prognosis cannot be given in those cases in which operation is refused, since it has occurred that the hæmorrhage has been absorbed and the evidence of acute pressure disappeared. In these cases, and others not operated upon, whole gland feeding may have some effect on the symptoms mentioned above, but certainly not as marked as in those cases operated upon and treated by subsequent feeding.

The results in operations upon acromegalies are not so indefinite, due possibly to the fact that operation has been performed after hyperpituitarism has produced its results and not at the inception of the disease.

There has generally been a recession of the swelling of the soft parts but no effect upon the bones. Menstruation has been restored in several cases (Hochenegg, von Eiselsberg), and Cushing reports the return of male sexual function one year after operation which was supplemented by gland feeding. The eyesight when involved has been favourably affected. There has not been a marked loss of weight even with feeding. It is to be noted that those cases of acromegaly which have gone over into the state of hyperpituitarism with mental symptoms seem to be markedly benefited by feeding without operation (Cushing). Sufficient observations have not accumulated to give us any data as to the effect upon growth in the incipient cases.

The effect in adiposis dolorosa, von Recklinghausen's disease, various dyspituitarisms, and allied conditions cannot be stated at this time.

As to the type of tumour. The favourable results in cysts have already been commented upon. The adenomata should be divided into two groups, those which have grown out of the sella and become intracranial, and those still intrasellar. In the former group Hirsch reports 13 cases, in which the local pressure was relieved with considerable improvement of vision and at the time amelioration of certain general symptoms, but for the most part the operation may be described as palliative.

In the second group, in which are often found the early acromegalies, there are often no typical signs and symptoms; atypical evidences, however, have caused a resort to the X-ray, and the bulging sella with a narrow outlet has confirmed the diagnosis. This is the type of case offering the greatest possibility of cure if attacked promptly. This possibility is emphasized by the brilliant result obtained by Halstead, in whose patient (suffering from an adenoma) there has been no return of the tumour after more than three years. When malignant tumours occur, the outcome is of course fatal.

CHAPTER IX

OPERATIONS FOR HYDROCEPHALUS INTERNUS: OPERATIONS FOR CEPHALOCELES

OPERATIONS FOR HYDROCEPHALUS INTERNUS

Indications. Hydrocephalus internus may be congenital or acquired: in the former case, the pathology is obscure, and doubt exists as to whether the ventricular distension arises from primary changes in the ventricular ependyma or from obstruction to the outflow of cerebrospinal fluid from the fourth ventricle. Acquired hydrocephalus results from the presence of a subtentorial tumour, from thickening of the membranes in the region of the foramen of Majendie, and from other known causes. The results of operation are not sufficiently satisfactory to enable the surgeon to urge operative interference until medicinal and other remedies have been tried and found wanting. No fixed probationary period can be laid down as a guide, but it is perfectly clear that the surgeon cannot possibly carry out operation with benefit to the patient if the ventricular distension is allowed to progress to such a degree that marked cortical flattening and degeneration result. Surgical treatment to be efficacious must be undertaken at an early stage of the disease.

Operation. Operations are carried out (*a*) with the object of withdrawing fluid from the distended ventricular spaces (ventricular puncture), and (*b*) to establish a communication, or short-circuit, between the ventricular and cerebral subarachnoid spaces (ventricular drainage).

Ventricular puncture is indicated in congenital cases, whilst ventricular drainage is called for in acquired hydrocephalus and in those congenital cases in which improvement after repeated puncture ends in relapse.

Ventricular puncture. This may be carried out through the anterior fontanelle, through the frontal bone, or over the descending cornu of the lateral ventricle.

(*a*) *Through the anterior fontanelle.* The region of the fontanelle is shaved and cleansed in the usual manner, after which the surrounding parts are cut off from the field of operation by the application of a sheet of gauze or lint, in which a hole is cut sufficing to allow of the exposure of the site of election for puncture.

The patient should be in the recumbent position, the head well towards the end of the table and turned slightly towards the side on which the operation is to be carried out. The operation can be performed without an anæsthetic or under local anæsthesia. The ventricle can be tapped with either a small trochar and canula or syringe. The former instrument is preferable. A site is chosen at the outer angle of the fontanelle, about ¾ inch away from the median antero-posterior line, thus avoiding the line of the superior longitudinal sinus. The evacuating instrument is passed directly inwards, towards the base of the skull, for a distance of not more than 2 inches. The trochar is withdrawn, and the fluid allowed to escape. If the cerebro-spinal fluid escapes at high pressure, the flow should be regulated with the finger placed over the mouth of the canula, and, in any case, it is inadvisable that more than 50 cubic centimetres should be allowed to flow away at any one sitting. The effect of the withdrawal of the fluid must be carefully noted, and at any sign of collapse on the part of the patient the outflow must be stopped at once. After withdrawal of the canula, the site of tapping is covered with collodion gauze, maintained in position by strapping. Subsequent bandaging of the head (preferably with an elastic bandage) may assist in preventing the reaccumulation of fluid. Although the condition of the patient shows improvement after ventricular puncture, the operation usually requires to be repeated several times before material benefit results.

(*b*) *Through the frontal bone.* When the anterior fontanelle is closed the ventricles may still be tapped from above. Tillmanns,[1] in recommending this procedure, writes, ‘The needle should be inserted about 2 centimetres from the central line and 3 centimetres from the precentral sulcus. You strike the ventricle at a depth of from 3 to 5 centimetres.’ Trephining is usually necessary as a preliminary measure.

(*c*) *Over the descending cornu of the lateral ventricle.* This operation possesses one great advantage in that efficient drainage is supplied. It is strongly advocated by Keen. A point is mapped out on the skull which lies 1¼ inches behind the external auditory meatus and the same distance above Reid's base-line (see Chapter I). A bradawl is introduced at this point so as to indent the external table of the skull. A small scalp-flap is then framed, suited to the region to be explored. The pin of the trephine is applied to the indicated spot, and the disk of bone removed. The posterior branch of the middle meningeal artery ramifies in the immediate neighbourhood, and due care must be taken to avoid injury to this vessel. After the exposure of the dura mater, the trochar and canula are introduced through the dura, directed towards the summit of the opposite ear, and passed for a distance of not more than 2 inches. The cerebro-spinal fluid is allowed to escape with precautions similar to those enumerated above. The disk of bone should not be replaced. The scalp-flap is sewn into position. If a second puncture should be required, the syringe can be introduced without difficulty through the scalp and trephine hole. When the lateral fontanelles are open, the evacuating instrument can be inserted without previous trephining.

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[1] *Brit. Med. Journ.*, October 24, 1908.

Ventricular drainage. Drainage of the lateral ventricles is carried out to the best advantage by first adopting *Keen's*[1] method of ventricular puncture. The diagnosis being confirmed, the gap in the skull is enlarged up to a diameter of 1 to 1¼ inches, and the dura incised crucially, the dural incisions being carried to within a short distance of the margins of the gap. The trochar and canula are now introduced into the lateral ventricle and some 50 cubic centimetres of cerebro-spinal fluid allowed to escape. A few strands of catgut, tied together in the form of a bundle, are then passed through the canula in such a manner that the distal ends project into the ventricular cavity, whilst the proximal portion is tucked either into the subdural, extra-dural, or subaponeurotic spaces. Drainage into the subaponeurotic region tends to convert the state of internal hydrocephalus into one of cephalocele, whilst extra-dural drainage seldom permits of sufficiently rapid reabsorption of the cerebro-spinal fluid. Undoubtedly, subdural drainage allows of the best results. In this method, the proximal ends of the catgut are insinuated between the brain and the dura mater. The dural incision is sewn up, and the scalp-flap replaced.

More recently, a method has been adopted, and in some few cases with encouraging results, in which tubes of decalcified bone were substituted for the catgut bundle. This change was recommended after it had been found that the absorption of the catgut and the falling together of the brain substance usually prevented the formation of the fistulous channel between the ventricular and cerebral cerebro-spinal spaces.

Burghard uses decalcified bone tubes in the following manner: An ordinary tube is cut obliquely through its central part, and the two halves sewn together with catgut in such a manner that they lie at right angles to one another. The tube is then introduced so that one segment projects into the lateral ventricle, the other into the subdural space. Accurate approximation of the dura mater is desirable in order to limit the escape of cerebro-spinal fluid, a troublesome complication. An attempt should therefore be made to sew up that membrane, though this is always a matter of considerable difficulty.

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[1] *Surgery. Its Principles and Practice,* vol. iii.

The bone tubes will be absorbed in the course of time, but, it is hoped, after the formation of a fistulous channel between the ventricular and cerebral cerebro-spinal spaces.

Puncture of the Corpus Callosum. The treatment of internal hydrocephalus is often very efficiently treated by puncture of the corpus callosum (see Chapter VII).

OPERATIONS FOR CEPHALOCELES

Under the definition 'cephalocele' are included all those cases in which, as the result either of trauma or of congenital deficiency in the formation of the vault and base of the skull, there is a gap in the skull through which the membranes alone (meningocele), or membranes and brain (meningo-encephalocele), outwardly bulge.

OPERATIONS FOR CONGENITAL CEPHALOCELES OF THE VAULT AND BASE OF THE SKULL

Indications. According to the late Professor von Bergmann,[1] the indications for operation are as follows:—

(i) Inoperable cases:

Those associated with premature synostosis and microcephaly.

Those associated with hydrocephalus or marked deformity.

Those in which the tumour is situated below the external occipital protuberance.

(ii) Inoperable cases:

Limited protrusions with none of the above defects and disadvantages.

These indications may be accepted as affording a general basis on which to estimate the feasibility of operation. Each case, however, must be considered on its own merits, and no case must be dismissed as inoperable without the fullest investigation. For instance, those cephaloceles which are situated below the external occipital protuberance are included in the inoperable class because it has been found that the osseous defect in the occipital bone sometimes extends into the foramen magnum, because such cephaloceles are occasionally complicated by a condition of cervical spina bifida, and because the sac of the hernia sometimes contains a portion of the cerebellum itself. Such conditions are, however, by no means the rule, the cephalocele not infrequently possessing but a narrow pedicle and only communicating with the interior of the subtentorial space by means of a narrow channel. The mere fact also that the sac contains neuroblastic elements does not by any means imply necessarily that those elements are of vital importance to the individual. Lyssenkow[1] pointed out that these cephaloceles are in reality of the nature of teratoid tumours, a fusion of epiblast and mesoblast, and that it is the exception rather than the rule for a cephalocele not to contain some material of neuroblastic origin.

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[1] *Beiträge zur klinischen Chirurgie,* vol. vii, p. 228.

It must also be borne in mind that, without operative interference, the case is almost necessarily fatal, although, now and again, more favourable results are reported.

Insomuch also as the tumour generally tends to increase in size, thus still further widening the gap in the skull, the operation should be carried out as soon as the surgeon is satisfied that the general condition of the patient warrants such interference.

Operation. The unhealthy condition of the overlying integument, especially at the apex of the tumour, prohibits any extensive preparatory cleansing, this process being carried out for the most part when the child is under the anæsthetic.

Scalp-flaps are framed from the region of the base of the tumour, advantage being taken of the more healthy integument. These flaps must be so sized and framed that accurate approximation and complete protection to the gap will be subsequently attained. The flaps are dissected back to their base. The pedicle of the tumour is defined and an endeavour made to detach it completely from the margins of the osseous defect. This is usually a matter of considerable difficulty. The sac of the tumour should then be tapped with trochar and canula, and the fluid contents allowed to escape slowly, after which the membranes are slit up towards the base of the protrusion with blunt-pointed scissors.

When dealing with a pure meningocele, the membranous protrusion is cut away in such a manner as to leave merely sufficient tissue to allow of closure of the dural gap. This closure can either be carried out by means of a purse-string suture, or by the union of two lateral flaps. In either case, accurate approximation is essential in order to prevent as far as possible the escape of cerebro-spinal fluid.

If the sac should contain an irregular mass of neuroblastic material, apparently not true cerebral or cerebellar substance, this material can be dissected from the membranous sac, ligatured at the base, and freely cut away.

If the sac should contain true brain substance, the possibility of excision can be raised. In the cerebellar region such measures are contra-indicated, and the surgeon must remain content with an attempt at replacing the cerebellar substance within the cranial cavity. This reposition will be aided by elevation of the head and by lumbar puncture. If the protrusion corresponds to a region which has no known motor function, it may be cut away with the scalpel flush with the bone. The hæmorrhage may be considerable, but can be controlled by pressure, by irrigation with hot water at a temperature between 110° and 115° F., by the cautery, and by ligature of bleeding points. When bleeding occurs, a drainage tube should be inserted. Shock is often very severe, and these radical measures must not be lightly undertaken.

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[1] *Der Hirnbruch und seine Behandlung* (Dissert. Moskowa, 1906).

To remedy the osseous defect, Lyssenkow[1] recommends an osteoplastic operation, turning down from the skull above the defect a flap which comprises the pericranium and the external table of the skull. The flap is so turned down that the pericranial surface becomes internal, the fragment of bone being suspended by the continuity of the pericranium. He reports 72 cases so treated, with 37 recoveries and 35 deaths.

König and von Bergmann,[2] oppose this osteoplastic method on the ground that the extreme thickness of the skull does not usually allow of the splitting off of the external table, and that, even when such a course is feasible, the fragment undergoes necrosis.

Transplantation of calcined and decalcified bone, silver, and celluloid plates have all been tried with no great degree of success. Smoylenko proposes paraffin or vaseline injections, especially for the nasofrontal variety of cephaloceles.

When the surrounding bone is of such a nature that it is possible to form an osteoplastic flap, this measure should be adopted. In other cases, it appears preferable that no immediate attempt should be made to remedy or protect the gap in the hope that nature will repair the defect in part, the surgeon aiding the process at a later date by carrying out one of the measures advocated for the protection of gaps in the skull (see Chapter V).

OPERATIONS FOR TRAUMATIC CEPHALOCELES

Indications. Though traumatic cephaloceles are comparatively of rare occurrence, yet sufficient data are at hand from which to formulate certain points with regard to the question of treatment. The patients are usually in the first three years of life, the protrusion is commonly placed over the right parietal bone, and it develops within two or three weeks of the accident. The fracture is simple in nature, the bone fissured, and the dura torn, whilst through the membranes and osseous gap the congested and œdematous brain bulges outwards.

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[1] *Der Hirnbruch und seine Behandlung* (Dissert. Moskowa, 1906).

[2] *System of Pract. Surg.*, vol. i.

Operation. For the remedying of this condition three courses are available:

Aspiration and puncture. The tumour is tapped with the trochar and canula or syringe, and the fluid contents withdrawn. Little benefit results, as the tumour is mainly composed of brain substance. It is barely necessary to state that injections of irritating fluids are condemned absolutely.

Exposure by open operation, followed by reduction or removal of the herniated brain substance. The operative details closely resemble those described previously when dealing with congenital cephaloceles. The local conditions are, however, in this case less favourable. There is a considerable defect in the bone, and the margins of the gap are almost invariably thinned and everted. The site of the protrusion also usually prohibits the removal of the herniated brain substance.

Expectant treatment, combined with the application of pressure. The surgeon is compelled as a rule to adopt this third alternative.

Results. In a series of 37 cases collected by the writer,[1] the following results were obtained:—

An operation was carried out in 5 cases, with 2 recoveries and 3 deaths.

Aspiration resulted in 13 recoveries and 9 deaths, the high mortality being mainly due to the fact that operative measures were carried out in a considerable number of cases before the days of aseptic surgery. An expectant attitude was adopted in 9 cases, with 8 recoveries and 1 death.

The term 'recovery' merely refers to the early result obtained. A complete recovery, with recession of the brain and complete closure of the gap in the skull, must be regarded as of excessively unlikely occurrence. The majority of cases die within a few months of the accident.

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[1] *St. Barts. Hosp. Reports,* vol. xl.

SECTION V

OPERATIONS UPON THE CENTRAL NERVOUS SYSTEM

PART II

OPERATIONS UPON THE SPINAL CORD AND CANAL

BY

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CHAPTER X

OPERATIONS FOR SPINA BIFIDA

Indications. The term spina bifida includes all forms of congenital cleft of the coverings of the spinal cord as well as many malformations of the cord itself, so that cases range in severity from the simplest forms of meningocele, which may even undergo spontaneous cure, to the most severe deformities of the nervous system, which are incompatible with life and insusceptible of useful treatment. In many it is impossible to operate with any hope of cure, and it is probable that many, if not most, of the cases will never come within the reach of surgery. On the other hand, very satisfactory results may be obtained by a judicious selection of cases and adaptation of the operation to the conditions, so that we are at the outset principally concerned with the selection of cases for operation and the selection of the method of operation.

In connexion with the *tumour* we shall be guided principally by its size, the condition of its coverings, and the amount and nature of its nervous contents. The most satisfactory cases are those in which the projection is small and stationary in size, or with very slight increase or decrease, while the coverings are intact and quite free from ulceration, and the sac has few nervous contents or none at all. Departures from this type render the results of operation less hopeful, and extensive ulceration of the cutaneous covering, perforation of the sac with leakage of cerebro-spinal fluid, or the presence in the sac of much nervous tissue, whether in the form of a meningo-myelocele or of a syringo-myelocele, will make success highly improbable.

Age is a factor of much importance. On the one hand, all the more radical operations are associated with considerable shock, so that it is advisable, when possible, to defer them until the end of the first year of life or even later. On the other hand, it is during the first year that the majority of cases die from ulceration and sepsis or from other causes, and thus considerable danger is again incurred by waiting, while the development of function after reposition of nervous structures is much more likely to be secured if the operation be performed early. It will, therefore, largely become a matter of judgment in each individual case how early an operation is to be performed. Other things being equal, the earliest date should certainly be chosen, but the general condition may render delay essential at all costs, while in the case of very young children the operation should be the simplest and most rapid which is likely to preserve life. It may also be possible to temporize by occasional aspiration of the sac, and thus to defer a more radical operation until the attainment of a safer age.

Distinct *hydrocephalus* is a definite contra-indication to operation, and has in many cases been rendered much worse thereby, but slight hydrocephalic conditions need not deter us and are not incompatible with spontaneous or post-operative recovery. Severe *paralysis* of the lower limbs generally indicates an amount of injury to the nervous structures which will render all operations futile, and such paralysis has even been aggravated by operation.

Cases may then be classified somewhat as follows:—

1. Suitable for operation.

(i) Sacs of moderate size, or comparatively slow growth, with few or simple nervous connexions, and with intact or comparatively healthy coverings.

(ii) Cases which remain stationary, or which, after spontaneous retrogression, cease to improve.

2. Unsuitable for operation:

(i) Cases presenting small tumours with intact skin and marked tendency to contract, many of which recover spontaneously.

(ii) Large sacs with leaking contents or widely ulcerated surfaces, in which sepsis will almost certainly follow any interference.

(iii) Cases of marked general marasmus or severe hydrocephalus or paralysis of the lower limbs.

Spina bifida occulta and the cicatrices of old and healed spina bifida will be considered in connexion with the operation of laminectomy.

EXCISION OF THE SAC

Indications. Excision of the sac with or without plastic closure may be regarded as the operation of election and should always be adopted when practicable. Yielding the best results in simple meningoceles, especially in those with a narrow pedicle and *a fortiori* in those in which the pedicle is imperforate, it may also be adopted in myelomeningocele, although in the larger and more complex forms the results are disappointing. In syringo-myelocele this, in common with all other treatment, is probably useless. Extensive ulceration, leakage of cerebro-spinal fluid, hydrocephalus, and extensive paralysis are, however, absolute contra-indications to excision, although small areas of ulceration which can be disinfected and excised need not debar from operation.

Operation. The *instruments* required are a small scalpel, scissors, dissecting forceps, fine toothed forceps, pressure-forceps, wire retractors, a blunt dissector, and a probe; a strabismus hook is useful for the retraction of nerve trunks. Fine curved intestinal needles with holder and chromicized catgut are used for the deeper sutures, and for the skin sutures silkworm-gut or horsehair.

The operation presents several distinct stages, not all of which may be required, viz. (1) the excision of thinned or ulcerated skin and reflection of two flaps of healthy skin, (2) the evacuation of fluid contents and excision of the expanded meninges, (3) the replacement in the spinal canal of extruded nervous tissues, (4) the watertight closure of the gap in the soft parts. Further proceedings, if adopted, may be described as ‘plastic’ operations.

The child is anæsthetized with chloroform and placed on its face with the head low to guard against loss of cerebro-spinal fluid. Warmth and a thick swathing of cotton-wool should be used to minimize shock, and it may be advisable in the case of very large sacs to gradually diminish tension by previous aspiration for several days before the radical operation (Reid, *Med. Record,* Oct., 1899). The tumour and adjacent skin are cleansed, and any patches of ulceration present should be touched with some strong antiseptic such as pure carbolic acid, and removed as early as possible in the operation.

In rare cases, in which the whole of the cutaneous covering is of good thickness, it may be possible to reflect this as a single flap, preferably from above downwards, a single incision round the upper half of the tumour being used for this purpose.

Far more commonly two curved incisions will have to be made over the more prominent part of the tumour so as to include between them a spindle-shaped area of the thin cutaneous covering. These incisions unite above and below, and should include between them any skin which is too thin to heal afterwards, but it is essential that they should leave on their outer sides enough sound skin to cover over the gap without the slightest tension, and, if this cannot be done, it may be necessary at a later stage of the operation to make other lateral incisions outside of the original one so as to allow of gliding inwards of two cutaneous bridges (see Fig. 233). In the majority of cases the elliptical area of excised skin will have its long axis vertical and in the middle line as in the drawing, but where the sac is very low down it may be useful to make the incisions horizontal so that the wound may not encroach too nearly upon the cleft of the nates, where it is in danger of being soiled. It is also advisable, in all cases where there is a sufficient amount of sound skin to leave any choice to the surgeon, to make the incisions in such a way that one lateral flap is larger than the other, so that the final line of suture will lie to one side of the middle line; the deeper incisions can then be placed to the opposite side, the covering layers thus overlapping, and the risk of leakage being greatly diminished.

The lateral flaps of skin and subcutaneous tissue thus marked out by the two incisions are next carefully dissected or peeled outwards from the sac, great care being necessary to avoid sudden rupture of the latter, as the rapid escape of cerebro-spinal fluid may cause severe shock. When the sac has thus been thoroughly cleared it must be carefully examined, and the nature of its contents and attachment to the spine should be fully investigated. It will then be ascertained whether the tumour is a simple meningocele with a narrow or wide neck, or whether it contains nervous structures.

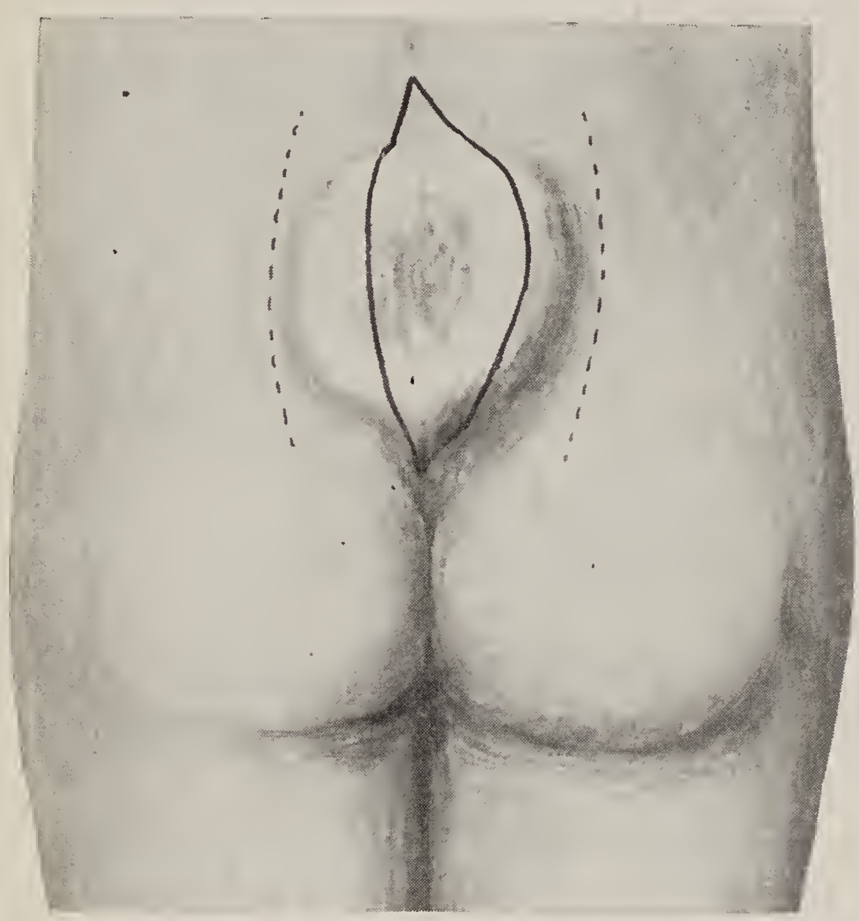

FIG. 233. SPINA BIFIDA. *Incisions for excision of the sac.* The dotted lines indicate the incisions which may be required to allow approximation of the flaps.

In the case of simple meningocele with a narrow neck it now suffices to ligature the latter, and after cutting off the sac to close the skin wound over the stump. If the neck be at all wide, or if there be any contents other than fluid, it will, however, be necessary to proceed with the opening of the sac and a careful dissection of the deeper parts.

In the majority of cases the sac will thus require to be opened, and it will often be found to contain various structures the return of which to the spinal canal is essential. It is in connexion with this portion of the operation that its principal dangers—shock from profuse flow of cerebro-spinal fluid or interference with nervous structures, and meningitis—arise, and great caution should therefore be used to avoid a sudden escape of its contents. Before making the opening, the upper end of the sac should be compressed with gauze to prevent a gush of fluid from the spinal canal. A minute opening is then made to allow of the gradual escape of the cerebro-spinal fluid, after which it is converted into a free incision. The latter incision must not be placed in the middle line, and must avoid any depressed areas in which it is likely that nerve tissue is adherent. It should also be planned in such a way that the line of meningeal suture is lateralized and removed as far as possible from the line of skin suture, and this can be done more effectively in the deeper incision of the meninges than in the skin, in which little latitude will be possible in the formation of flaps.

When a free incision has been made, nervous contents will again be sought for and, if present, dealt with, but if there are no such contents the redundant sac is now cut away and the meninges closed by a continuous suture of fine catgut, great care being taken to leave sufficient margin to allow of suture without tension.

The disposition of the nerve structures inside the sac varies much, the most useful classification from an operative point of view being that given by Chipault (*Chirurgie Opératoire du Système Nerveux,* 1895, vol. ii, p. 10), who describes the following types:—

1. The nervous tissue may be spread over the inner surface of the sac. There may be found—

   (i) A thin layer of medullary matter spread over the whole inner surface of the sac.

   (ii) The spinal cord, more or less atrophic, may be adherent to the sac in the middle line, whilst the nerves arising from the involved stretch of cord are adherent to the sac-wall as they pass to their foramina of exit.

   (iii) The spinal cord may be normal, but has contracted secondary adhesions to the sac. The nerves arising from it are adherent as in (ii).

2. The nervous elements are confined entirely to the middle line of the sac, and the nerve trunks, instead of running round its walls, pass straight across it to their exit.

3. There are no nervous elements within the sac, except bands stretching backwards into it from the spinal canal. These bands are of very different types and values: they may represent the cord itself, or perhaps a much enlarged filum terminale; whilst in some cases the band consists only of a large nerve which ends in the supply of the sac itself.

The separation of these structures is often a matter of great difficulty. They must be most carefully isolated from the sac with a blunt instrument, and where their adhesions appear very tough it is advisable to return a small portion of attached sac with the nerves rather than to prolong unduly an operation in which rapidity is essential to success. It is also of essential importance that none of the bands entering the sac should be cut across until the operator has satisfied himself that they do not leave it again at a lower point. When all the structures have been freed they should be gently returned within the spinal canal, and, the redundant sac having been cut away, the gap in the meninges is closed as usual by a continuous suture of fine catgut. If it be thought inadvisable to prolong the operation by any more elaborate attempt to deal with the defect in the spinal column the skin wound is now closed, No drainage should be used, and it is well to employ mattress sutures so as to obtain a broad ridge of apposition, followed by accurate closure of the epithelial edges with a continuous suture. In cases of great tension this may be further relieved by passing the deep or mattress sutures round two pieces of rubber tubing (Stiles, *Brit. Med. Journ.*, 1902, vol. ii, p. 673). The best dressing is a seal of collodion and gauze covered by aseptic wool, which should be frequently renewed. For some days after the operation the child should lie upon its face with the head low, as there is here no irritant fluid to flow from the sac, and we have only to guard against the flow of cerebro-spinal fluid into the wound.

Plastic operations. Many surgeons limit the operation to excision of the sac with suture, and consider any further interference unnecessary and unjustifiable, but there is no doubt that in suitable cases a more perfect result may be attained by methods which aim at occluding the bony defect in the spine. The advantage to be thus gained from the lessened risk of leakage and the provision of a firmer scar should, however, be held to justify the performance of a plastic operation only when the local condition of the cleft and the general condition of the child permit a prolongation of the operation.

The nature of the plastic operation will be determined by the size of the opening, and especially by the condition of the rudimentary laminæ which bound its sides, the methods which have been employed or suggested being conveniently arranged in three groups.

On the soft parts. The simplest form of this operation consists in *utilizing the sac as a plug* to close the gap in the spinal canal. After it has been cleared and opened, and its contents dealt with, it is closely folded upon itself and, instead of being excised, is fixed in the opening by a few points of suture; the skin wound is then closed in the usual manner.

A more satisfactory method consists in raising *flaps of the adjoining muscular and aponeurotic structures,* drawing these inwards and suturing them across the opening. After the sac has been cut away and sutured, the skin flaps are raised so as to expose the vertebral aponeurosis for a distance of about 1 inch on either side of the opening in the spine. A deep vertical incision is then made on each side parallel to the middle line, and a stout bridge of aponeurosis and muscle is raised off the bones by blunt dissection, as in raising the muco-periosteal flaps for the ordinary operation of staphylorrhaphy—the two bridges, attached above and below, being freed sufficiently to enable them to meet in the middle line without tension. They are then brought together over the cleft and closely united by suture, while it is advisable to rotate them slightly on their long axes so that they are approximated by their deep or muscular surfaces and form, when united, a strong crest over the opening. The skin flaps are then replaced and closely sutured as before. This operation yields a strong thick covering, and probably affords effective protection; in the sacral region the bridges of tissue contain aponeurosis only, but this is strong and provides a firm fibrous covering.

With osteoperiosteal flaps. A still more perfect closure of the spinal defect may be obtained by the formation and approximation of osteoperiosteal flaps, and if the laminæ bounding the cleft are not in an altogether rudimentary condition, they undoubtedly supply the best material for the closure of the cleft. To obtain such closure in the dorsal and lumbar regions the laminæ on each side of the opening are cleared of their overlying soft parts, without being stripped of periosteum or separated from one another, and they are then divided with bone-cutting forceps as far outwards as possible at their junction with the pedicles and articular processes. There is thus raised on each side a bridge, containing the detached laminæ with their intervening ligaments, which is fixed to its fellow of the opposite side as in the case of the musculo-aponeurotic bridge above described, silver wire sutures being useful for this purpose.

Bobroff (*Centralblatt für Chirurgie,* 1892, p. 465) has carried out a similar manœuvre in the case of sacral defects. The gluteus maximus of one side is first raised from the ilium and carried outwards from that part of its origin adjacent to the cleft. A portion of the iliac bone, 1 centimetre in thickness and large enough to cover the spinal cleft, is then raised with a chisel or gouge from the posterior part of the iliac crest, but its periosteum is left uninjured at the inner side of the plate, and constitutes a hinge about which the fragment is turned over and inwards so as to cover the deficiency in the middle line. Bobroff also suggests that a similar procedure could be employed in cases of spina bifida of the dorsal region, in which laminar flaps could not be obtained, by stripping an osteoperiosteal flap from the ribs and utilizing it to cover the deficiency in the column. This modification of the method would, however, involve extensive separation of muscle in order to bring the flap to its destination by the shortest route, and it does not appear to have been actually adopted.

Involving the grafting of foreign bone and other substances. Lastly, various attempts have been made to close the spinal defect by the introduction of plates or strips of foreign bone or periosteum, or even of other materials. Such methods present the objections, which are inseparable from all bone-grafting operations, but they have here the great advantage that they shorten the time of the operation, as the material to be implanted can be prepared before the operation is commenced, and the latter is therefore not more serious or more difficult than simple excision of the sac. Thus it is only necessary to resect and suture the sac, and at once to superimpose a thin layer of prepared material (bone, periosteum, or celluloid), holding it in position by a few sutures and closing the skin over it.

For the purposes of the graft, Mayo Robson (*Brit. Med. Journ.*, 1883, vol. i, p. 558) has used strips of periosteum from the femur and frontal bone of a freshly killed rabbit, and other surgeons report successful cases in which small fragments of rabbit periosteum were simply scattered over the exterior of the sutured meninges. Perier (*Sem. Méd.*, May 18, 1892) and others have carried the same principle still further by the introduction of plates shaped from the fresh scapula of the rabbit, which is well adapted to the purpose, and Sljamer (*Wien. med. Wochenschr.*, 1900, No. 12) has utilized a celluloid plate embedded beneath the skin, while Roswell Park has also employed ivory and silver foil (*Trans. Amer. Surg. Assoc.*, vol. xxiii).

Results. The more complicated cases complicated by a bundle of nerve tissue within the sac give poor results as to permanent restoration, to relief, and also as to mortality. In the cases of meningocele, however, and those cases in which only nerves are in the sac, unless there is very wide separation of the canal making it impossible to cover it in by a muscular transplant, which is probably the preferable method, the results are very satisfactory as to restoration of function on the part of the nerves and as to mortality, particularly if the operation is performed quickly with the head low, so that no fluid is lost, and sepsis does not intervene. As to the ultimate result, however, a fair proportion, the exact number of which cannot be determined but possibly from 15 to 35%, develop hydrocephalus.

CHAPTER XI

LAMINECTOMY

From an etymological point of view the term laminectomy is open to objection, but the more correct forms of lamnectomy and rachiotomy have never found general acceptance, while the expressions 'resection of the vertebræ' and 'resection of the vertebral arches' are cumbrous, so that the nomenclature which has now become general will be adopted throughout the following pages. Earlier writers have commonly employed the expression 'trephining the spine,' but this has now been discarded and has the double disadvantage that the trephine is seldom actually used, while a very false analogy is suggested with operations upon the skull.

As with many other branches of surgery, the operative treatment of affections of the spinal cord and its membranes is of very recent development, but suggestions may be found as far back as in the writings of Paulus Ægenetus and Fabricius Hildanus, while Louis (1762) was apparently the first to act upon these in a case in which he successfully removed fragments of a vertebral arch broken by a gunshot wound. The first deliberately planned operation appears, however, to have been that of Cline, who, on the suggestion of Sir Astley Cooper, operated in 1814 upon a case of 'fracture-dislocation' of the eleventh dorsal vertebra, removing two spinous processes and one arch; the spinal cord was almost torn through, and the patient died on the nineteenth day. From that time until 1889 about sixty or seventy more or less similar operations were undertaken in cases of spinal injury, the majority in the United Kingdom and in America, but the results were by no means encouraging, and no definite 'surgery of the spinal cord' could be said to exist.

In the case of pressure lesions of the cord the first efforts of surgery were naturally of later date, but in 1882 Jackson of Sheffield operated upon a case of paraplegia due to spinal caries, obtaining an amount of recovery which, if not complete, was at least very striking. Within the next two years the work of Macewen of Glasgow brought prominently into notice the surgical treatment of this form of paraplegia, and from that date laminectomy has been constantly performed for disease as well as for injury. Sir William Gowers and Sir Victor Horsley, in their classical case (1887) of removal of an intrameningeal tumour (*Med.-Chir. Trans.*, 1888, vol. lxxi), gave the subject further impetus, and the fortunate coincidence of improvements in general surgical technique with a precise appreciation of the localization of function in the various segments of the cord has so far extended the possibilities of surgical treatment that, since 1890, laminectomy has been adopted for a large number of diseases as well as for traumatic conditions.

NEUROLOGICAL LOCALIZATION

The essential basis of all spinal surgery is a correct localization of the seat of disease, which is sufficiently simple in the case of injury and in some cases of caries, but which is less simple where we have to deal with tumours. It will therefore be convenient at the outset to consider very briefly the functions of the various spinal segments and their anatomical position in relation to the available bony landmarks of the back. In so doing, all controversial matter will be avoided as far as possible, and for fuller details reference must be made to works upon neurology.

Motor paralysis usually extends upwards as far as the muscles supplied by the affected segment of the cord, and in cases of incomplete paralysis it may be taken as a general rule that of those segments which lie below the lesion the higher are more paralysed than the lower. *Sensory defects,* on the other hand, tend to be more marked in the lowest segments, so that the upper level of *complete* loss of sensation may be a considerable distance below the level of the lesion. The dissociation of tactile and pain sense is, however, common, and it may be found that appreciation of such stimuli as the prick of a pin is lost to a much higher level than appreciation of tactile sense, while deep sensations in bone and muscle persist even below the level of complete cutaneous anæsthesia. Hence, in determining the upper level of a lesion, it is essential to ascertain the very highest level at which there is any defect of any form of sensation, and not to regard the boundary line of *full* anæsthesia as determining the segmental level of pressure. *Pain* is generally most marked in the distribution of the highest affected segment, or of nerve roots which arise above the segment and are compromised in their intravertebral course; in the case of intrameningeal tumours, the long duration and fixed position of pain are especially valuable indications of the site and nature of the lesion. The presence or absence of *reflexes* is of comparatively little value in ascertaining the level of a lesion except in so far as it enables us to distinguish lesions of the cord from those of the cauda equina.

The localizing value of motor symptoms is greatest in the case of the brachial enlargement, and the extent of paralysis of the arm muscles can be accepted with great certainty as determining the site of the lesion in the cord. The risk of error is also lessened in the cervical region by the fact that the intravertebral course of the nerve roots is comparatively short, not greatly exceeding an inch even in the case of the first dorsal root. In the whole of the dorsal cord the motor functions give very little assistance in segmental diagnosis, as it is not easy to define which of the intercostal muscles are in action and which are not. In the lumbar enlargement the various segments become so crowded together, all lying within the vertical depth of three vertebræ, that their differentiation by motor symptoms is almost, if not quite, impossible.

Sensory symptoms—if due regard be paid to ascertaining the highest level of any defect—are of equal value with motor symptoms in the case of the cervical enlargement. In the dorsal cord they have a far greater value, and it will be upon sensory defects that we shall now principally rely. In the lumbar enlargement the difficulties due to crowding of segments are as great as in the case of motor symptoms. In every region hyperæsthesia and pain, when present, are generally due to pressure upon nerve roots rather than upon the cord itself, and they will thus locate the source of pressure as being between the medullary origin and the vertebral exit of the root concerned. Thus, anæsthesia and paralysis extending to the limits of one segment, with pain or hyperæsthesia and with or without paralysis of one or two segments above, would indicate that the cord was compressed at the level of the segment showing anæsthesia, while the higher segmental symptoms were due to involvement of the roots lying alongside the compressed cord.

In the case of the lumbar enlargement the segments occupy so short a vertical distance that their differentiation becomes very difficult, but for surgical purposes this is of comparatively little importance, as the whole area can be exposed by the removal of some three arches. We are now, however, met by the difficulty that the intravertebral course of the spinal roots is long, extending in the most extreme case from the lower border of the first lumbar vertebra to that of the third or fourth sacral, a distance of several inches. It thus becomes important to distinguish affections of the cauda equina from those of the cord itself, and especially from those of the conus medullaris, a distinction which is the less easy as, in cases where pressure is above the lower border of the first lumbar vertebra, both may be involved. We may, however, lay down the following as general rules, admitting that they are not infallible guides:—

1. Marked asymmetry of the symptoms points to the cauda equina as their seat of origin.

2. Exaggeration of deep reflexes points to the lesion being in the cord and above the reflex arc, which in the case of the knee-jerk is the second and third lumbar, and in the case of ankle clonus and the Babinski reflex is situated in the first, second, and third sacral segments.

3. Abolition of the deep reflexes generally indicates a lesion of the nerve roots, the loss of the reflex being determined by interruption of either the afferent or the efferent fibres. In cases of extreme pressure and severe crushes, the reflexes may be abolished by damage to the reflex centre in the cord itself, but in such cases the anæsthesia and paralysis will tend to be more complete than in lesions of the cauda equina alone.

4. Where there is a clear restriction of symptoms to a limited portion of the lumbo-sacral area the lesion will almost certainly be caudal rather than medullary, as in the latter case almost all segments are involved, either together or in rapid succession.

5. Similarly, the slow progress of symptoms from segment to segment will point to a caudal lesion.

6. Pain and hyperæsthesia will here, as elsewhere, indicate an affection of the nerve roots rather than of the cord itself, and great severity or long continuance of pain point strongly to the cauda equina.

7. Where symptoms of paralysis and anæsthesia are incomplete we find that, if the cauda equina be affected, both tend to be most marked in the lowest roots, while in the case of an affection of the spinal cord paralysis usually reaches its highest level in the area of the segment attacked.

With these preliminary considerations we may proceed to indicate the functions of the various spinal segments, and, although there is still considerable difference of opinion on certain points of detail, these are now sufficiently well defined to admit of a tabulation which is enough for the purposes of the surgeon. The annexed tables and diagrams are, therefore, only approximately accurate, and are intended to express what I take to be the collective opinion of various observers, while they differ slightly from my own earlier work, which has in the last twenty years been amplified and revised by many neurologists.

PRINCIPAL MUSCLES SUPPLIED BY EACH SPINAL SEGMENT

Cervical I.	Small muscles of neck and distribution of descendens noni nerve.
Cervical II and III.	Diaphragm, sterno-mastoid, trapezius.
Cervical IV.	Diaphragm, supraspinatus, infraspinatus.
Cervical V.	Biceps, brachialis anticus, deltoid, supinator longus, supinator brevis.
Cervical VI.	Subscapularis, pronator quadratus, pronator radii teres, teres major, latissimus dorsi, pectoralis major, serratus magnus, triceps.
Cervical VII.	Long extensors of the wrist and fingers, secondary supply of many of the muscles of the sixth segment, and of flexors of the wrist and fingers.
Cervical VIII.	Long flexors of the wrist and fingers.
Dorsal I.	Intrinsic muscles of the hand.
Dorsal II to XII.	Intercostals and abdominal muscles.
Lumbar I.	Abdominal muscles.
Lumbar II.	Abdominal muscles, cremaster, psoas (?), iliacus (?), sartorius (?).
Lumbar III.	Adductors, psoas, iliacus, sartorius.
Lumbar IV.	Quadriceps femoris, glutei, obturator externus.
Lumbar V.	Hamstring muscles, glutei.
Sacral I.	Muscles of calf, gluteus maximus.
Sacral II.	Extensors and flexors of the ankle and toes, peronei, intrinsic muscles of the foot.
Sacral III.	Perineal muscles, intrinsic muscles of the foot.
Sacral IV and V.	Bladder and rectum.

This table is to be regarded as a compilation from the work of various writers, and not as expressing in all cases the personal observations of the author. As far as possible all doubtful cases are entirely omitted, and those muscles only are named whose condition may fairly be relied upon for purposes of diagnosis. In the case of the lower lumbar and upper sacral segments especially there is still much uncertainty.

THE SENSORY DISTRIBUTION OF THE SPINAL NERVE ROOTS

This has been more fully studied than have the motor connexions, and the diagrams published by various writers[1] present considerable differences, but I am still of opinion that the figures which I published from 1887 to 1896 represent with sufficient accuracy the data for regional diagnosis. These are now reproduced with some minor modifications, embodying later work or the researches of others, and they are drawn asymmetrically so as to show as far as possible in diagrams (see Plates I and II) the principal variations and the more marked differences in the opinions of various observers.

SKELETAL LOCALIZATION

The localization of the lesion *in relation to the spinal cord* having been determined, it is also necessary to ascertain the level at which it is situated *in relation to the bony points* which can be felt, as the various medullary segments are not situated opposite the bodies of the vertebræ whose names they bear, and still less do they correspond to the spinous processes of those vertebræ. Thus, the brachial enlargement of the cord lies approximately opposite to the third, fourth, fifth, sixth, and seventh cervical spines, the lumbar segments opposite the eleventh and twelfth dorsal, and the sacral segments opposite the spinous process of the first lumbar vertebra. In somewhat fuller detail it may be calculated that, in the region of the neck, each segment lies higher than the tip of the correspondingly named spinous process by about one segment, so that, for instance, the fifth cervical nerve roots arise from the cord at the level of the spine of the fourth vertebra. In the dorsal region there is considerable variation, but approximately each medullary segment lies under the spinous process of the second, or, lower down, of the third vertebra above that which bears the same name and number, until we find the twelfth dorsal segment under the ninth spinous process, after which the remainder of the cord is so short that the termination of the conus medullaris is situated immediately beneath the gap between the first and second lumbar spines, the eleventh dorsal spinous process

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[1] Starr, *American Journal of the Medical Sciences,* July, 1892; *Brain,* 1894, p. 431. Head, *Brain,* 1893, p. 1. Mackenzie, *Medical Chronicle,* August, 1892. Kocher, *Mitteilungen aus den Grenzgebieten der Medizin und Chirurgie,* Jena, 1896. Thorburn, *Surgery of the Spinal Cord,* London, 1889; *Brain,* 1893, p. 355; *Medical Annual,* 1896, p. 97; *Brain,* 1903, p. 120. Seiffer, *Das spinale Sensibilitätsschema,* Berlin, 1901.

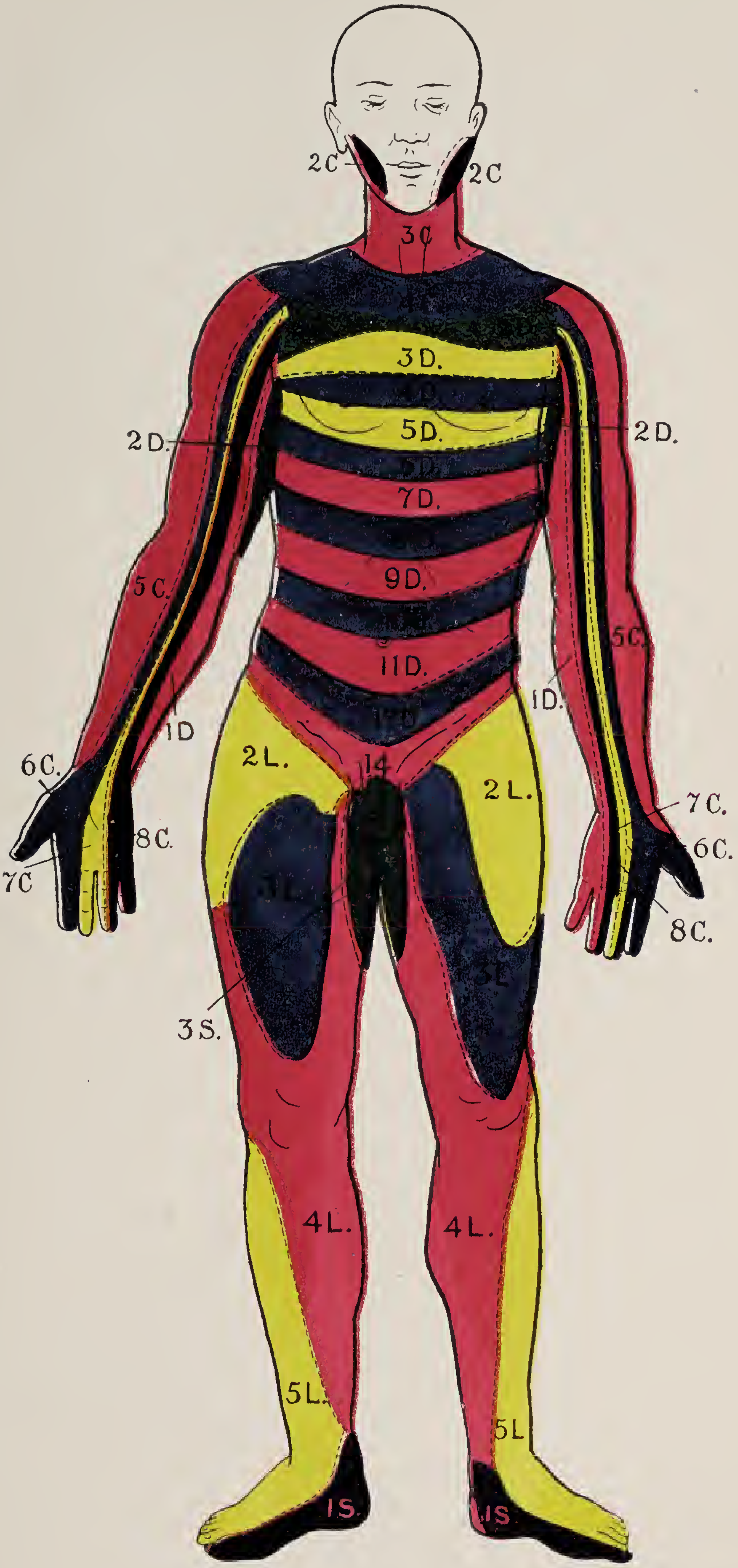

Plate I.—Diagrammatic representation of the Sensory distribution of spinal segments (anterior view).

lying over the third and fourth lumbar segments, and the twelfth spine over the sacral region of the cord. The whole of these relations have been very carefully worked out by Reid (*Journ. of Anat. and Phys.*, 1899, vol. xxiii, p. 341), who has also illustrated in diagrammatic form the extent of variation usually met with (see Fig. 234).

Lastly, it must be pointed out that, even in regard to 'surface anatomy,' it is by no means always easy to define and count the spinous processes, and that, in stout people especially, it may be almost impossible to be quite certain as to their distinction. It is generally wise, in all difficult cases, to count both from above and from below, and to obtain the agreement of at least two observers. In so doing, the necessary calculations may be made from the axis, the seventh cervical spine, the last dorsal or second sacral spine, or from the lower end of the sacrum. The seventh

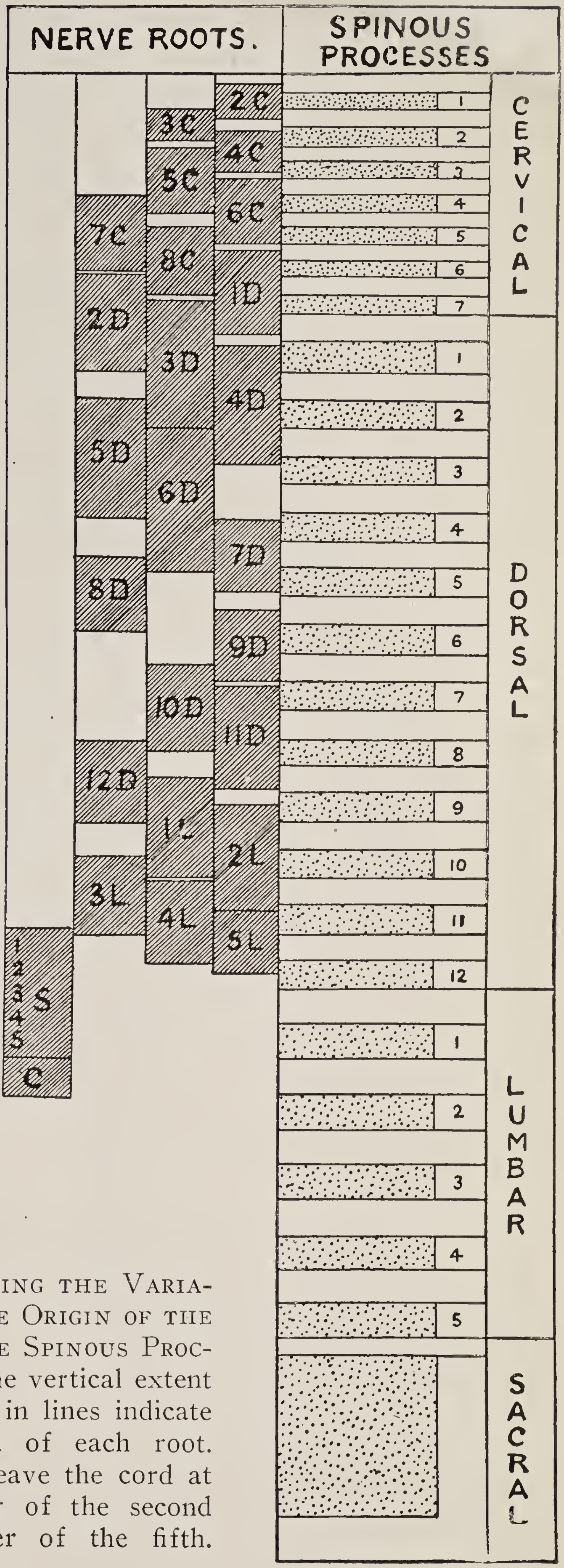

FIG. 234. A DIAGRAM INDICATING THE VARIATIONS IN THE RELATIONSHIP OF THE ORIGIN OF THE NERVE ROOTS TO THE APICES OF THE SPINOUS PROCESSES. The dotted areas indicate the vertical extent of each process; the areas shaded in lines indicate the extreme variations of origin of each root. Thus, the sixth dorsal root may leave the cord at any point from the lower border of the second dorsal spine to the upper border of the fifth. (*Modified from Reid, loc. cit.*)

cervical spinous process is by no means always so prominent as the name 'vertebra prominens' implies, and it and the first dorsal spine are liable to be very close together and to be regarded as one process only. The last rib indicates the position of the twelfth dorsal vertebra, but may be itself difficult to identify, while it is impossible to trace it with precision to the vertebra and its spine, and we have to rely upon a somewhat doubtful mental picture of the relation of these structures. The posterior inferior spines of the ilia can almost always be defined, and these appear to bear a constant relation to the second sacral spinous process, which lies between them, so that it is not difficult to count upwards to the desired vertebra. In practice, the writer generally works upwards from the twelfth dorsal and downwards from the seventh cervical, and if the results do not agree, or if the region investigated be low down in the spine, the second sacral is used as an alternative landmark. In the neck the spine of the axis can be felt, but those of the third, fourth, and fifth cervical vertebræ cannot as a rule be defined, although the sixth is often distinctly prominent. It may also be occasionally convenient to remember that the hyoid bone is opposite the body of the fourth cervical vertebra; the cricoid cartilage is opposite that of the sixth; the top of the sternum is opposite the lower border of the body of the second dorsal; the lower angles of the scapulæ, when the arms are by the sides, correspond very roughly to the spinous process of the seventh dorsal or body of the eighth; and the umbilicus is opposite the disk between the third and fourth lumbar vertebræ or the tip of the third lumbar spinous process, the tops of the iliac crests being lower by the depth of one vertebra.

Lastly, in many cases, a skiagram will be required as a preliminary to operation, and it may be found useful in obtaining this to place a metal button or coin over the spine of a vertebra, such as the twelfth dorsal, whose position has been previously estimated; the picture will then confirm or correct the landmark.

INDICATIONS FOR OPERATION

The operation of laminectomy has been adopted in various conditions, some of which necessitate special procedures, but in all of which the greater part of the technique is identical, so that the indications may first be considered collectively under the following headings:—

(i) Injuries of the spinal cord, including pressure due to bony displacement, hæmorrhage, foreign bodies, callus and cicatrices, and section or tearing of the cord and its membranes.

(ii) Injuries of the cauda equina.

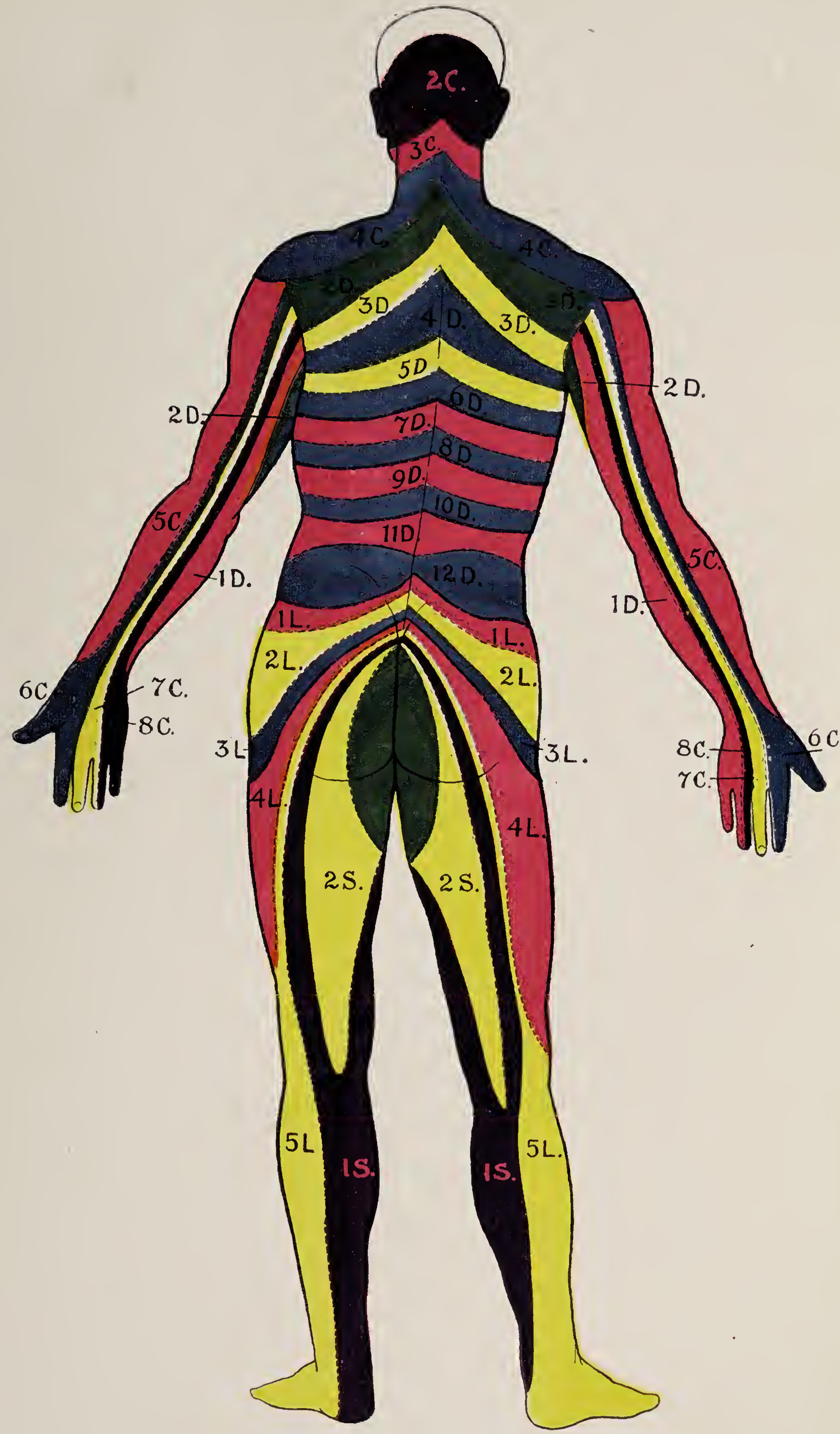

PLATE 2.—Diagrammatic representation of the Sensory distribution of spinal segments (posterior view).

(iii) The effects of tuberculous and other forms of caries of the vertebræ.

(iv) Tumours, including cysts, of the spine, meninges, nerve roots or cord, spina bifida occulta, and the cicatrices of old spina bifida.

(v) Inflammatory affections of the meninges.

(vi) Intractable neuralgia of the spinal nerves.

Injuries of the spinal cord. The injuries for which operation has been suggested or undertaken vary considerably in their nature and include the most diverse conditions.

1. *Fractures of the spinous processes alone* are very rare, there being only two cases recorded among Ashhurst's 394 collected injuries to the spine, and seven among Gurlt's 270 collected fractures. Personally, I have met with but two examples and I have found records of twelve, in only three of which the cord was injured, so that operation cannot often be required for this condition. When it does occur the removal of the fractured spinous process presents no difficulties and is not, strictly speaking, laminectomy, but it hardly appears to be called for in uncomplicated cases. If, however, the fragment be depressed or wedged between adjacent laminæ so as to give rise to fixation of the spine or to much pain, and especially if it be associated with any evidence of injury to the contents of the vertebral canal, its removal is certainly indicated, and, in the case of injury to the cord, it will generally be wise also to remove one or even two adjacent laminæ, so as to allow a full exposure of the damaged region and to ensure the complete removal of any fragments of bone.

2. *Fractures of the laminæ alone* are more important, although equally rare, but the wisdom of removing detached laminæ can hardly be doubted, as, even if they are not primarily associated with pressure symptoms, there is a considerable risk of their becoming depressed at a later date. In a few cases this operation has been performed, one of the most satisfactory being that of Schede, in which the sixth dorsal arch was detached and driven in upon the theca, causing complete paralysis and anæsthesia with vesical and rectal paralysis: the arch was removed sixteen hours after the injury and complete recovery ensued. In several other cases the same procedure has been adopted, although it has not been invariably successful.

3. *Fractures and dislocations of the bodies of the vertebræ* may be considered together as 'fracture-dislocations,' the technical distinction between the two conditions rarely being of practical importance. In the case of unilateral dislocations of the cervical vertebræ the cord is frequently either intact or but very slightly injured, and reduction of

the deformity is often practicable. Under such circumstances a cutting operation is not required, but, should there be symptoms pointing to any injury of the spinal cord, the advisability or otherwise of performing laminectomy will be decided by the considerations which apply to other fractures and luxations.

In the common ‘fracture-dislocation’ the upper vertebra is displaced forwards in such an overwhelming preponderance of cases that all other forms may be neglected, and the lower vertebra is usually broken obliquely as in the annexed figures. Under such circumstances the spinal cord and its nerve roots are compressed between the posterior part of the body of the lower vertebra and the arch of the upper one, the injury being possibly increased by traction upon the cord during the extreme flexion to which the fracture is generally due. In many such cases the displaced bones remain displaced, and the theca and its contents, if not torn quite across, are subject to continuous compression, as in the specimen shown in Fig. 235. In other cases there follows immediately after the injury a considerable amount of recoil, and the pressure, having been momentarily inflicted, is again relieved, the vertebral canal being left quite patent as in Fig. 239. In the experience of the writer, about two-thirds of all pathological specimens show such recoil, so that there is no permanent pressure upon the cord, while in only about one-third is continued compression demonstrable at an operation or a post-mortem examination.

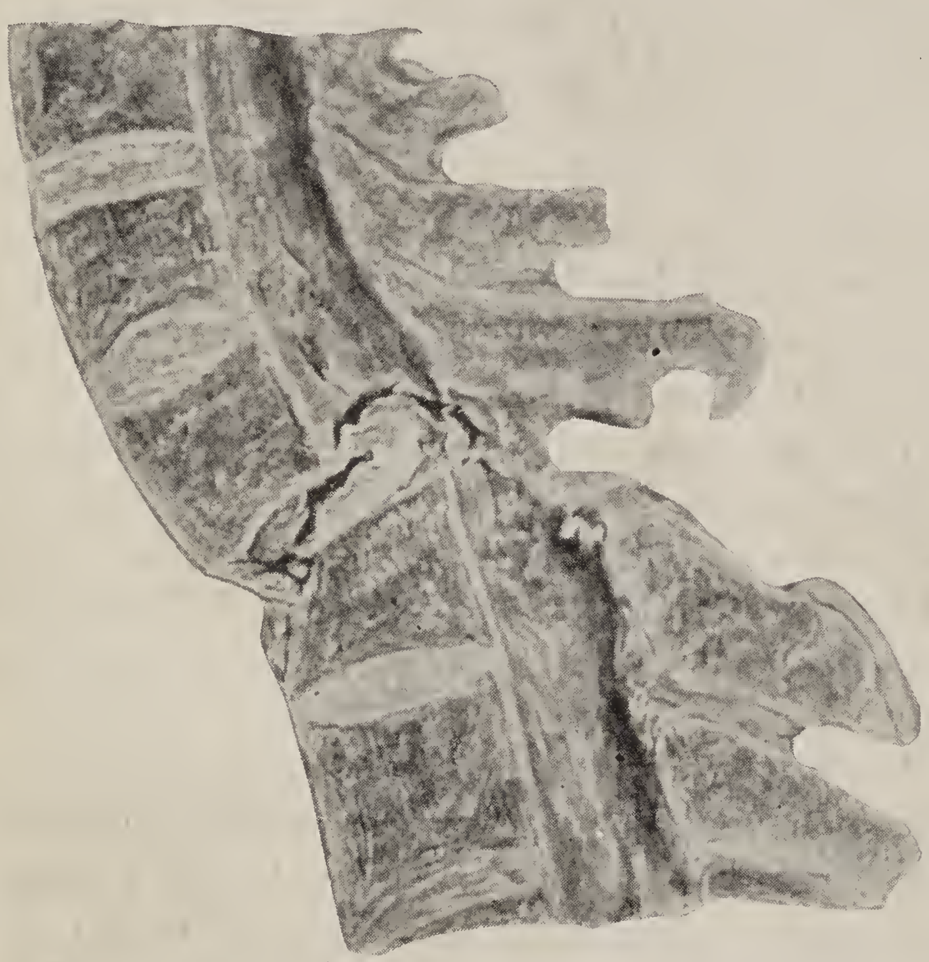

Fig. 235. Fracture-dislocation of the Cervical Spine, showing Persistent Displacement. The cord and theca were torn across completely.

More rarely the damage done to the contents of the vertebral canal may result, not from kyphosis and crushing of the cord between the lamina of one vertebra and the body of the next, but from impaction of a small detached fragment of bone, from the forcing backwards of an intervertebral cartilage, which forms a projecting shelf pressing upon the cord, or from hæmorrhage into the theca or perithecal space. Traumatic hæmorrhages into the cord itself are probably always the result of one or other of the forms of injury already enumerated, although in many cases of hæmatomyelia the displacement is so slight and transient that it cannot be readily recognized as a dislocation, and is conveniently described as a 'diastasis.'

The injury inflicted upon the cord in connexion with these various conditions may consist of mere contusion with intramedullary hæmorrhage (hæmatomyelia), or contusion with continued compression, or of complete rupture; and in each case it will usually be followed by softening or myelitis, which extends for some distance beyond the original focus of injury, and by ascending and descending degenerations similar to those met with in other forms of transverse myelitis.

The possible variations in the exact nature of the injury being thus recognized, it will be obvious that somewhat different results may be anticipated from laminectomy under the various conditions. Where the cord has been crushed and immediately released by recoil, there being no further bony pressure, the only object of operation will be to remove effused blood or to suture a torn cord or theca. Where, on the other hand, the displacement is not followed by recoil, the removal of the arch of the upper displaced vertebra, or of the projecting angle of the lower vertebra,

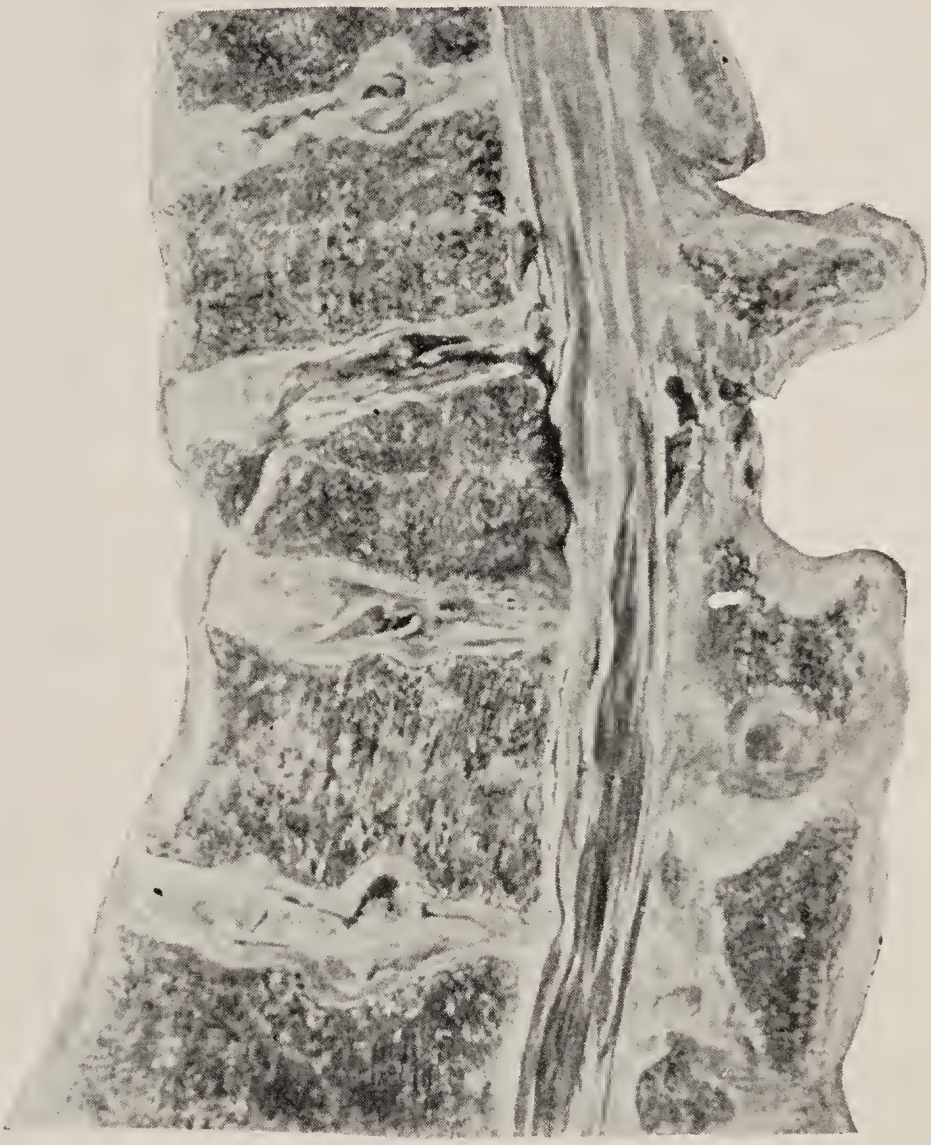

Fig. 236. Fracture-dislocation at the Dorso-lumbar Junction. The damaged theca and its contents are fully released from pressure by recoil.

will relieve the compression, as well as allow of the escape of blood or the use of sutures. These are the two conditions met with in the great majority of cases, and neither of them offers much prospect of successful treatment.

Injury by isolated fragments of bone is exceedingly rare, and I am not aware of any clearly reported examples in which it has been detected at and successfully treated by an operation. In injury by the backward extension of an intervertebral disk, as in that by isolated fragments of bone, the conditions more nearly resemble those of pressure by tumours, and there is some hope of a satisfactory result; but, again, such a condition is very rare and not likely to be recognized. In one of the writer's early cases the true state of affairs was discovered only after death on the sixteenth day after operation.

Extra-medullary hæmorrhage sufficient in amount seriously to compromise the cord, and unaccompanied by bony displacement, is also rare. The bleeding in these cases is generally derived from the veins of the spine itself and leads to the formation at the seat of injury of a clot which encircles and compresses the theca. In the case of Church and Eisendrath (*Amer. Journ. of Med. Sci.*, April, 1892) a fracture-dislocation of the tenth dorsal vertebra was associated with paraplegia; laminectomy disclosed a firm extra-dural clot which was removed, and recovery was almost complete. Wagner also records, a case of bullet wound at the level of the ninth dorsal vertebra in which, three months after the injury, a firm fibrous cicatrix, apparently due to a clot, was removed with complete cure of the pre-existing paraplegia. Equally rare is the condition which may be described as 'gravitating hæmorrhage,' met with by Bennett, Liddell, myself, and others, and probably due to hæmorrhage inside the dura mater, with a collection of blood filling the theca from below upwards. In a suspected case—that is, in a case of spinal injury followed by steadily ascending paralysis—the diagnosis could probably be made by meningeal paracentesis, and it is conceivable that such paracentesis might relieve the symptoms and lead to recovery; but, if it failed to do so, laminectomy and drainage of the theca holds out a hopeful prospect, although we have not met with an example in actual practice.

Although an attempt has thus been made to distinguish the various forms of injury which may be met with, and the prospects of successful operation in each, it is, however, very rarely that such distinctions can be made in actual practice. In the great majority of cases the diagnosis will be limited to the recognition of a fracture-dislocation with more or less complete paraplegia, and operation alone will determine the precise nature of the lesion. Under such circumstances the surgeon will realize that he has to deal with one of the three following conditions:—

(*a*) Displacement of a vertebra with crushing of the cord and immediate recoil, in which there is very little prospect of benefit from operation, as there is no necessity to remove pressure.

(*b*) Displacement *without* recoil, in which pressure can certainly be relieved, but in which the fatal analogy of those cases where the cord has been at once released by natural recoil leaves us little to hope from relief by art.

(*c*) Rare cases of injury by fragments of bone or cartilage or by hæmorrhage, in some of which beneficial results have certainly followed operation.

Taking this view, we cannot hope to find any very satisfactory results from laminectomy for recent injuries. Personally, I have operated only upon five cases of recent fracture-dislocation with crushing of the cord, and in none of these could I satisfy myself that any real good had been done. I also collected, some years ago, over 200 published cases in which the results were equally unsatisfactory. Life may of course be preserved in many cases in which the injury is not too high up or too complete, and even a considerable amount of recovery of function may occasionally occur, but such results are met with equally among cases not operated upon, and it is not altogether uncommon to meet with a remarkable amount of spontaneous recovery or a remarkable prolongation of life among well-nursed spinal injuries.[1] In regard to published records, it is also important to remember that in many cases of hæmatomyelia a large amount of recovery may ensue, even where paraplegia appears at first to be complete, and such recoveries cannot justly be assigned to an operation which would tend to increase rather than to decrease the danger to life.

We may, then, conclude by laying down certain definite propositions:

(i) In the great majority of cases of fracture-dislocation with injury to the spinal cord, laminectomy is useless.

(ii) In a very few, operation may reveal a hæmorrhage, an impacted spicule of bone, or other removable source of pressure or irritation.

(iii) Operation must therefore never be held out as offering any but the smallest hope of success, but, the situation having been fully explained to the patient or friends, it may, if desired, be undertaken as a 'last chance.'

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[1] I would protest strongly against the tendency to abandon hope in all cases and to neglect those details of nursing and general treatment which ought to be carried out with the same determination to strive for success as in all other diseases.

(iv) If undertaken it should be complete, in the sense of including a search for, and removal of, all possible sources of pressure, including the pressure backwards of the body of the lower of the affected vertebræ (see *infra*).

(v) As regards the period at which it is to be undertaken, there is a general consensus of opinion that acute shock and hyperpyrexia are contra-indications, but, apart from these considerations, many surgeons urge operation at the earliest possible moment as being best calculated to save the spinal cord so far as possible. Lloyd (*Philadelphia Med. Journ.,* February 8, 1902) argues that we should wait until shock has passed away and events have shown that improvement in symptoms will not ensue, but that operation should not be delayed if symptoms are extending or if early improvement is arrested. Horsley (*Clinical Journal,* January 13, 1897) says, 'If the lesion is acute and in the cervical region, then certainly wait. As regards the dorsal region, it would be better to wait a little. As regards the lumbar region, I do not think you want to wait to operate.' Personally, having had no success in operation upon acute cases, and having seen many cases show a great amount of spontaneous improvement, I should prefer always to wait until satisfied that the cord was not destroyed. I doubt if we shall ever get beyond the position adopted by Lloyd, that 'it is the compression, and only the compression without injury to the cord, that can be benefited, and this may be taken as an axiom in the surgery of the spine.' Taking this view, it appears reasonable to wait until the case presents a stage of uncomplicated compression, unless, as in rare hæmorrhages, the latter be increasing in intensity.

The somewhat pessimistic view which I have thus ventured to express has remained unaltered after many years, and was originally arrived at only as a result of much disappointment. Nor can I regard the more enthusiastic opinions which are often met with as being based upon satisfactory evidence. The case in favour of operation can hardly be put more strongly than in the following quotation from Armour (*Lancet,* March 14, 1908): 'In respect to the question of operation in these cases, surgeons have been divided into three classes: those who advocate operation in every case of injury in which cord symptoms are present; those who advise operation in selected cases; and those who abstain completely from operation. To those who would operate upon selected cases I would say, as Walton does, "Surely, instead of selecting the occasional case for operation, we should rather select the occasional case in which operation is contra-indicated by profound shock, high and rising temperature, and the obvious onset of dissolution." To those who abstain from operation completely I would put this question: May we not by operation often save a life or rescue a patient from a helpless condition of a most disabling character?' I fear, however, that the answer to the question will be that we cannot *often*, but may *rarely*, save such a patient, and the decision is made greatly more difficult by the slight alteration. At the best it is hardly possible to go further than to admit, with Horsley (*Brit. Med. Journ.*, December 6, 1890), that 'trephining of the spine for injury is an operation of very slight danger intended to meet an almost hopeless condition, and the chance of its doing any good, although also very slight, is sufficient to render it a correct practice.'

4. *Wounds of the spinal cord*, such as are inflicted by sharp instruments entering between the laminæ or otherwise, will occasionally, but rarely, be met with. The history of such cases where no operation has been adopted throws some light upon the whole question of spinal surgery, and I have therefore analysed a number of published examples. In forty cases of stabs or cuts by sword, bayonet, knife, or chisel the meninges were wounded; of these cases fifteen died, and of the deaths nine were due to septic infection. So far, therefore, as mortality is concerned, the dangers are not great, apart from sepsis, which would be diminished by full exposure and cleansing of the wound. The escape of cerebro-spinal fluid is a common symptom, but never a very serious one. As regards the recovery of function of the cord the results are, however, bad. In only thirty-four of the forty cases was the cord injured, the remaining six being limited to the meninges or the cauda equina. Of the thirty-four cases in which the cord was involved, twenty-one survived, and of these three appear to have recovered entirely, sixteen presented permanent paralysis or anæsthesia or both, and two were said to be improving when last seen. In the great majority of cases the wound is followed by paraplegia, which shortly passes away, leaving a crossed paralysis and anæsthesia of the Brown-Séquard type; that is to say, one-half only of the cord has been cut and the first effects of hæmorrhage and pressure rapidly pass away, but the actual section is not repaired.

5. *Gunshot injuries of the spinal cord* are considered in Vol. V.

6. *The late results of injury to the cord.* The above remarks apply more particularly to laminectomy in recent injuries of the cord, but there remain to be considered those cases in which the injury has been survived but has left more or less complete paralysis, or in which recovery is followed by the later development of compression paraplegia.

The prospects of benefit from operation will here depend upon the nature of the residual lesion. If paralysis and anæsthesia be complete and permanent, and especially if they be associated with abolition of the deep and visceral reflexes, the probabilities are that the cord has been completely crushed and that operation will reveal a mere fibrous cicatrix lying within and more or less completely united to a theca which may, or may not, be itself compressed. Such cases are quite hopeless. On the other hand, less severe symptoms, and especially symptoms of late development or of gradual evolution, are often due to compression by callus, pachymeningitis, or it may be unabsorbed blood-clot, and cases of this class are susceptible of great improvement; they again fall into the class of compression injuries and not into the hopeless class in which the cord has been destroyed. Laminectomy may therefore be regarded as indicated in all cases of old injury with persistent symptoms, except perhaps in two groups which occupy the extreme ends of the scale, viz. (1) those in which the symptoms point clearly to complete destruction of the cord and (2) those in which the residual symptoms are stationary and so slight as not to give rise to practical inconvenience. In doubtful cases exploration is probably quite justifiable. In eleven operations undertaken for old injuries of this type I have five times found the cord converted into a fibrous cicatrix and have obtained no improvement, but the remaining six all showed some amount of recovery of function, three presenting very great improvement although the results of descending degeneration were permanent.

Injuries of the cauda equina. The nerve roots which constitute the cauda equina are more closely allied in their physiological functions to peripheral nerves than to the more vulnerable spinal cord, and Kahler, Chipault, and others have shown that in animals these may be cut and sutured with complete recovery of function, while in man Tuffier sutured the two first lumbar roots, which had been divided by a bullet wound, and obtained perfect recovery. There is thus much more reason for hope after crushing and other injuries of these roots than after injuries of the medulla itself, and experience fully confirms this view. Many cases of fracture-dislocation below the level of the first lumbar vertebra, or even at that of the dorso-lumbar junction, are followed by complete return of function even after paraplegia has lasted for weeks or months, and I may almost go so far as to say that such cases will generally recover unless there be distinct separation of the ends of the nerves by distance, or by the interposition of fragments of bone, foreign bodies, cicatrices, or callus. Should spontaneous recovery not ensue, laminectomy has here a definite objective, and nerve suture or the removal of pressure is certainly called for. It is also important to note that continued pressure, as apart from crushing followed by recoil, is far more common in this region than in the neck. It would therefore appear that in injuries of the cauda equina laminectomy is likely to prove of great value, but as spontaneous recovery may ensue it will not always be required.

The principal question, therefore, which arises in such cases will be that of the amount of delay which may be justified by the hope of recovery without operation. Speaking quite generally I have usually taken a period of six weeks as a somewhat arbitrary limit, and have operated after this interval if spontaneous recovery is not obviously in progress. In cases with marked deformity, as well as in those in which a skiagram shows great displacement, there is, however, a strong probability of apposition or close juxtaposition of the anterior and posterior bony walls of the vertebral canal, and in such it is advisable to operate at once, as the roots are now almost certain to be prevented by the interposition of bone from effecting their own repair. Severe vesical troubles will also indicate the necessity for early operation, although unfortunately in many injuries about the dorso-lumbar junction the vesical paralysis is due to an injury of the conus medullaris as well as of the cauda equina, so that the prognosis after operation becomes much less satisfactory. Probably the best general rule will be to operate at once in cases with very marked displacement, but in all other cases to await developments, operating early if the symptoms are severe and show no tendency to improve, but delaying in all cases in which the progress continues to be satisfactory.

Paraplegia of spinal caries. Spinal caries, associated with affections of the cord or nerve roots, is generally due to tuberculosis, but may result from syphilis, actinomycosis, and certain other conditions such as erosion by aneurysms. Of these, the last are quite beyond relief by laminectomy, while in syphilis and actinomycosis it will rarely be necessary or useful to operate for the relief of pressure, so that practically tuberculosis only claims attention in this section.

In a comparatively small number of cases tuberculous disease is limited to the spinous processes, laminæ, or articular processes of the vertebræ, and is producing paraplegia by direct pressure upon the spinal cord. In such the operation of laminectomy both removes the disease and relieves the complication, and its value cannot be questioned. We here simply follow the general rules which govern the treatment of tuberculous disease in readily accessible bones.

More important is the question of operation in paraplegia due to caries of the bodies of the vertebræ, with or without kyphosis. In such cases the cord is subject to pressure, and the paraplegia is of more or less gradual onset, but it is very rare indeed for the pressure to be due to bone; in other words, it does not generally arise from kyphosis with squeezing of the cord between the body of one vertebra and the arch of another, or from a secondary fracture-dislocation of the diseased vertebræ, and the bony canal of the spine is seldom much narrowed, although some narrowing may be present and may intensify the pressure.

The usual condition is one of pressure by tuberculous tissue within the vertebral canal, and such may exist as granulation-tissue, as caseous débris, as an actual abscess, or, in older cases, as a firm cicatrix of leathery consistence. All the usual modifications of 'cold abscesses' are also here met with, and fragments of necrosed bone may be present in the caseous mass. The cord itself plays a very passive part: it is pale and compressed, and degenerative changes ensue more or less quickly and may be associated with the usual 'system-degenerations' of compression myelitis. In such cases laminectomy removes the source of pressure, and the cord may, and often does, recover, the results being similar to those which follow enucleation of tumours of the meninges. Operation thus offers hopeful prospects as regards recovery of function, but it must include as complete a removal as possible of all tuberculous material outside the theca both anteriorly and posteriorly, while the theca itself should not be opened, as it is important that infection should not spread to its interior.

The two great difficulties in deciding whether to perform a laminectomy in paraplegia due to tuberculosis are, however, that some cases are so hopelessly progressive that operation is useless and recurrence almost certain, while in many others the probabilities of recovery are very good even if no operation be adopted.

On the one hand, it is seldom justifiable to operate when the general condition is very bad, when active tubercle is present in other regions, such as the lungs, or when there is evidence of marked activity of the disease in the form of hectic temperature or rapidly increasing kyphosis. In such active cases the wiser course is to wait and hope that improvement may render laminectomy a reasonably safe proceeding. It is also wise to ascertain before removing the laminæ that a sufficient amount of bone remains in the vertebral bodies to ensure the continuity of the spine, and, apart from symptoms, a skiagram may here give much information. With these reservations I may, however, say broadly that I am not often deterred from operating by the severity of the condition.

On the other hand, it must not be forgotten that the prognosis of paraplegia due to caries is exceedingly good if the patient be kept completely recumbent for a sufficiently long time, and the tediousness of such treatment need hardly be considered, as even after operation a long interval will be required for complete bony repair. It is, therefore, advisable in the great majority of cases to keep the patient absolutely at rest on the back for at least six months before resorting to operation. If, however, the symptoms be increasing steadily, and especially if they do so rapidly, it is probably useless to continue expectant treatment, and operation should be advised. In cases which become quite stationary after about six months there is also little prospect of a satisfactory result, especially if there be indications of descending degeneration, and in such operation should again be adopted. Cases which continue to improve should be left to nature, and a very large number will make a good recovery. Cases with marked 'trophic' or vesical symptoms are uncommon, but such symptoms appear to call for earlier operation.

The adoption of these rules will be found to limit very greatly the field of operation in paraplegia due to caries, and the results obtained are by no means good (*vide infra*). Early and frequent operation certainly yields a much larger proportion of satisfactory results, but it cannot be claimed that such results would not have ensued had more conservative methods been adopted.

Tumours. *Tumours of the vertebræ* are almost invariably malignant, and include primary sarcoma and myeloma and secondary carcinoma, sarcoma, and lympho-sarcoma. In such cases laminectomy is quite useless, and, where the diagnosis is established, it should not be adopted, although it is perfectly justifiable as an exploratory operation in doubtful cases. The coexistence of marked kyphosis with the general symptoms of pressure upon the cord will, however, usually determine the diagnosis, as will also the presence of malignant tumours in other regions. Benign tumours of the vertebræ, such as osteoma, chondroma, and myxoma, very rarely indeed grow inwards so as to press upon the spinal cord, but they may be met with and certainly call for operation. In one such case Hahn (*Neurolog. Centralblatt,* 1902, p. 621) obtained a good recovery.

Tumours growing within the substance of the spinal cord (intramedullary tumours) are by no means rare, however, occurring about one-third to one-half as frequently as the extramedullary growths. The types include sarcoma, tuberculoma, glioma, gumma, and other less frequent forms. These tumours may be multiple, encapsulated, or diffuse. Except on rare occasions, their removal should be by the method of extrusion in a two-step operation. The operator should not mistake the normal cervical and lumbar enlargements of the cord for intramedullary tumours.

Tumours of the meninges comprise over half of the intraspinal tumours and yield the best operative results. Such tumours may be extra-dural or intradural, the latter being somewhat more common.

The extra-dural forms include sarcoma and its modified varieties, as well as fibroma, lipoma, myxoma, lymphangioma, and hydatid cysts, and they may arise from the dura mater or the perithecal tissue or may penetrate to the vertebral canal through the foramina, in which case they are of course not truly meningeal tumours. The intradural tumours originate on the inner side of the dura mater or in the arachnoid or pia mater, and include sarcoma, fibroma, psammoma, myxoma, lipoma, endothelioma, fibro-sarcoma, fibro-myxoma, hæmangioma, lymphangioma, and (rarely) tubercle, gumma, and hydatid cysts or cysticercus. Neuroma and neurofibroma also grow from the nerve roots within the vertebral canal. Nearly all these growths are encapsuled and their enucleation is seldom difficult, while they do not appear to present any great tendency to recurrence. More than one-half have been described as sarcoma, but Harte suggests that it is probable that many of them have consisted of granulation-tissue, as sarcoma in other regions does not present this slight tendency to recur. If not removed they are necessarily fatal, if not to life, at least to the functions of the cord. After removal brilliant results are obtainable.

In all *doubtful cases* an exploratory operation appears fully justifiable. If the tumour be removable the gain is great; if it be malignant or irremovable no harm is done, and life may be considerably prolonged or death rendered much easier even in malignant growths of the bodies of the vertebræ, portions of which can be excised.

Syringo-myelia has occasionally been operated upon, as by Abbé and others, but the results are not encouraging and I should hesitate to interfere in cases of this class; if, however, by an error in diagnosis a case of supposed tumour prove to be one of syringo-myelia, the latter may be tapped through a fine needle, and in some cases temporary benefit has ensued.

In *spina bifida occulta* we have in effect a non-malignant tumour of highly complex structure pressing upon the spinal cord, or more commonly upon the cauda equina. Here operation is certainly indicated and here also the results are very gratifying.

In cases of cured spina bifida the cauda equina is also often pressed upon by cicatricial tissue, and the removal of this tissue may be followed by recovery which would not otherwise have occurred, as in a case recorded by my late colleague, Professor Thomas Jones.

Inflammatory affections of the meninges. Under the title of ‘Chronic Spinal Meningitis’ Horsley has recently (*Brit. Med. Journ.*, Feb. 27, 1909) described a number of cases in which he has operated. The true nature of many of these is still obscure, and doubtless they are by no means all of the same type, but they all appear to result from meningeal infection. The general symptoms resemble those of a tumour of the cord, but pain is less definitely localized and there are often widely spread hyperæsthetic areas: anæsthesia is incomplete and without dissociation: paralysis comes on as a widely spread weakness, often unilateral: there are no vaso-motor symptoms: the patients are almost always adults, and the upper level of anæsthesia is usually mid-dorsal; kyphosis is often present. Some of the cases appear to be due to syphilis, and several to recent gonorrhœa, while others are assigned to influenza.

Operating on twenty-one cases of this class, many of which had originally been regarded as due to tumour, Horsley found, as a rule, excess of cerebro-spinal fluid, thickening of the arachnoid, 'matting of nerve roots,' and compression of the cord with consequent anæmia. The operation consisted in free incision of the distended theca with irrigation by strong solutions of mercuric chloride, such as 1/2000, or even 1/500. The wound in the theca is left open, and it is suggested that the good results obtained are analogous to those produced by laparotomy in tuberculous peritonitis.

Spiller (*Amer. Journ. of Med. Sci.*, Jan., 1909) described a similar condition as 'circumscribed serous spinal meningitis,' and records a case cured by operation.

It appears probable that now that attention has been called to this condition its presence may in the future be more clearly recognized, and that its existence explains some of the cases in which a tumour has been diagnosed and not found. The writer has operated upon at least one case in which careful exploration for a tumour of the cauda equina, of which the symptoms were regarded as unequivocal, revealed no growth, but in which the theca presented distinct thickening and contained much fluid, while complete recovery ensued.

It is also important to note that, on the one hand, localized types of meningitis may, as Horsley suggests, readily give rise to subsequent acute myelitis, while the work of Orr and Rows has clearly shown how infections may reach the spinal canal along nerve roots and may thus set up local inflammatory processes.

While therefore it is still too early to define the limits of surgery in obscure cases of infective meningitis or of myelitis, there is at least some prospect that a more ready resort to laminectomy and evacuation or irrigation may arrest or cure certain of these.

Nerve root excision. Abbé (*Medical Record*, July 26, 1890) operated in two cases of intractable brachial neuralgia, excising the posterior roots and ganglia of the affected nerves, the result being that one case was somewhat improved, and the other not benefited. Similar and more satisfactory cases have also been recorded by Bennett (*Brit. Med. Journ.*, 1889, vol. i, p. 945), Horsley (*Brit. Med. Journ.*, December 6, 1890), Chipault (*loc. cit.*), and others, until brought practically before the profession by Ottfried Foerster in 1911, when he suggested and reported cases of dorsal root resection for spasticity and gastric crises of tabes.

Stimuli from the periphery through the posterior spinal roots to the anterior horn cells heighten the muscle tone. The motor cells of the cord are controlled and regulated by inhibitory influences through the pyramidal tracts; therefore, a withdrawal of this influence results in a hyperactivity of the reflex arc, producing spasticity. Theoretically then, cutting one limb of the reflex arc, *e.g.* the posterior roots, thus removing stimuli from the periphery, should diminish spasticity.

Tabetic crises are produced in some cases by irritation of the sensory sympathetic fibres in the posterior roots from the viscera, in others from vagus irritation. The former are benefited and the latter are not helped by root resection.

Root resection for pain is of little value in metastatic malignant spinal disease or in spondylitis. For amputation stump neuralgias it should be a last resort. Complete relief may follow resection if the pain is localized to one or several roots.

Congenital spastic diplegia (Little's Disease) furnishes one of the most frequent indications for resection of dorsal roots, but orthopædic management must not be neglected for root resection. The operation should not be done on imbeciles nor in advanced cases. It is best done between the fourth and seventh year.

Root resection may be done for the spasticity of multiple sclerosis when the disease has been latent one year.

Gastric crises of tabes justify the operation when they are severe and continuous or frequently recurring.

To identify the roots one must identify and mark a vertebral spine of the region to be operated. This should be confirmed with a lead marker and the X-ray. As the first step in the operation a transverse incision, 1½ inches in length is made over the identified spine through the skin. This obviates the danger of getting lost when the laminæ are laid bare by the long dorsal midline incision. Reference to Fig. 237 will show the root vertebral relationship. In the lumbosacral region identification of the roots can be made either from the fact that the first sacral root leaves the canal at the level of the fifth lumbar spine or that the first lumbar root lies on the fork of the lower extremity of the dentate ligament (Elsberg) (see Fig. 237). The fourth and fifth lumbar and first sacral are much larger roots than the upper lumbar and second

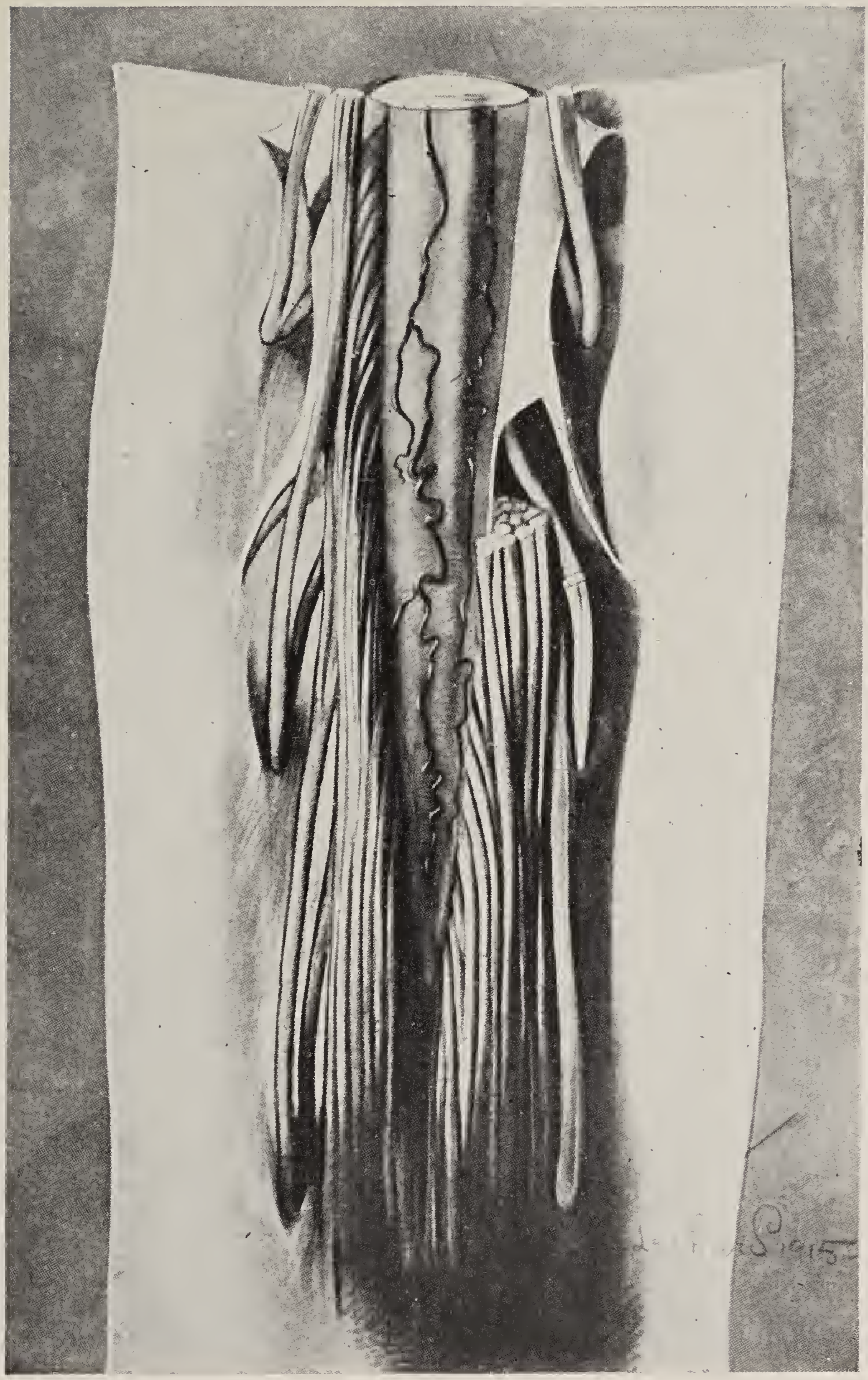

Fig. 237. The 'Fork' of the Dentate Ligament and its Relation to the First Lumbar Root. On the right side the roots have been cut to show the shape of the fork. X 1½. (Elsberg, *Diseases of the Spinal Cord.*)

sacral roots. Spines and laminæ must be removed so as to expose the roots at the level where they leave the dural sac.

In the cervical and dorsal region there is no difficulty in differentiat-

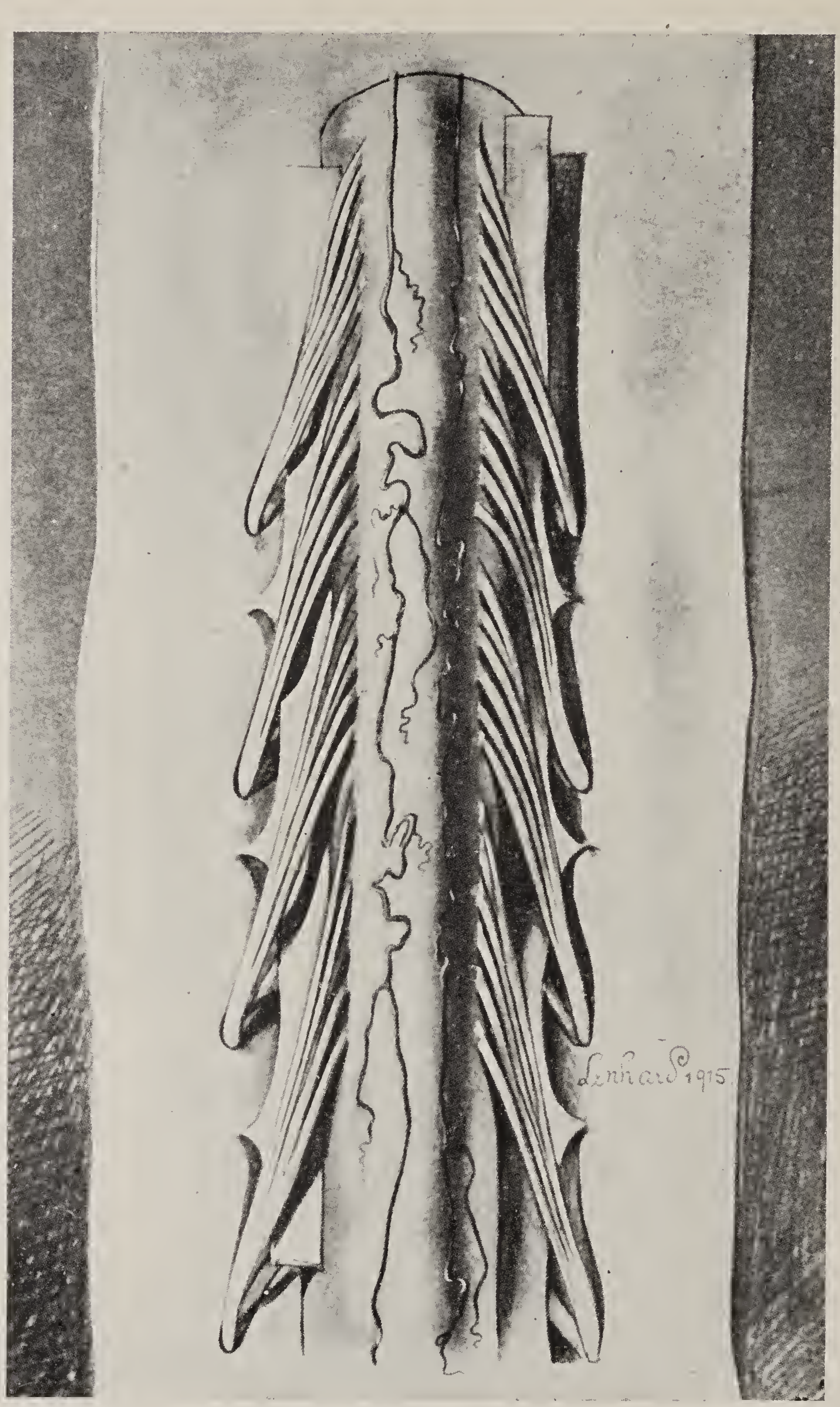

Fig. 238. The Relation of the Dentate Ligament to the Cord and the Dorsal Roots. X 2. (Elsberg, *Diseases of the Spinal Cord.*)

ing the dorsal and ventral roots, the former lying dorsal to the dentate ligament (see Fig. 238) and joining the latter near the dural opening. In the lumbo-sacral region the posterior root lies behind and to the outer side of the anterior and is usually larger. The posterior root is freed by raising the entire nerve on a strabismus hook and finding the line of cleavage. The posterior root is then divided at the dural opening and resected for a distance of one or two centimetres.

When operating for pain, one should divide more than the roots known to be involved, but it must be borne in mind that all the roots of an area cannot be divided, because an ataxia will result.

For spasticity, determine exactly the spastic muscles, estimate the relaxation desired to avoid ataxia before dividing. The fourth lumbar is usually left to preserve the extensor reflex but this nerve must be determined by stimulation with a low-grade faradic current applied to the roots at operation.

Tabetic crises usually require bilateral division of the sixth to the twelfth dorsal roots.

Steinke collected 132 cases of posterior root resection for all types of spasticity, of which 4 were cured, 97 improved, and 11 unimproved. There were 14 deaths within one month (operative) and 6 died after one month (delayed operative). Lower extremity cases gave better, often brilliant, results. Upper cases gave poor results. Of 73 cases for tabetic crises varying from 10 months to 25 years with an average of 6 years' duration, 14 were cured, 35 improved, 6 temporarily improved, 7 unimproved, and 10 operative deaths. There were 39 cases operated for pain. Seven were cured, 9 improved, 4 unimproved, 6 deaths within one month and 8 later than one month.

DIVISION OF ANTEROLATERAL TRACTS FOR PAIN

Spiller and Martin in 1912 devised this operation particularly for metastatic spinal disease or for irremovable growths in the lower extremities, because root section in these cases gives no relief.

The tracts lie between the dentate ligament and origin of the anterior nerve roots and are about 2 to 3 mm. in diameter. The division should be made in the mid-dorsal region unless the disease extends to a higher level. In unilateral disease the column of the opposite side of the cord only may be divided, but it is usually necessary to divide bilaterally. This removes pain and temperature sense below the division and the patient should be so informed so as to avoid exposure to extreme heat or cold.

The usual laminectomy is done, two spines being removed. A slip of the dentate ligament is cut and freed from the dura. Traction on this slip rotates and raises the cord. A von Graefe knife with the cutting edge directed outward is carefully introduced just in front of the dentate ligament to the depth of 2 to 2½ mm. and brought out just behind the origin of the anterior roots.

DECOMPRESSIVE LAMINECTOMY

Simple opening of the spinal canal and dura has a very striking influence upon some spinal diseases. Even in the absence of increased intradural pressure it may, and often does, effect some change which temporarily or permanently benefits or checks the symptoms of local spinal disease. Cases having been benefited are those with tumour symptoms in which no tumour or localized collection of fluid was seen, patients with symptoms and signs of multiple sclerosis with indefinite sensory symptoms, abnormalities of spinal vessels, syphilitic meningomyelitis in which the usual anti-syphilitic treatment had been given for a long time with no relief, chronic inflammatory lesions of the meninges or nerve roots, and in neuritis of the cauda equina. Not all cases operated are benefited by any means.

In the operation the laminæ should be removed well out to the articular processes and the dura widely incised, so that the fluid can escape freely. Adhesions when present should be separated and at the completion of the operation the dura, fascia, and skin are closed in the usual way.

TECHNIQUE OF THE OPERATION

Several varieties of incision and variations in detail of the operation are adopted by different surgeons, but, after trying many of these modifications, I have found that the straight mesial incision with complete removal of the laminæ gives the most satisfactory results, and I shall therefore first describe this and refer subsequently to other forms of operation.

Preparation. The *preliminary disinfection of the skin* of the back presents certain special difficulties, as it is coarse and thick, with many sebaceous and hair follicles, while in many cases there may be bed-sores seriously encroaching upon the field of operation. If possible, bed-sores should be induced to heal before operating, and in all cases they should, from the time when operation is decided upon, be most carefully dressed and disinfected as far as possible, great care being taken not to allow discharges to escape through or from under the special dressing of the sore. Overflow or involuntary discharges of urine into the bed must be carefully guarded against, and it is generally wise to use the catheter frequently before and after operation. Incontinence of fæces can be temporarily controlled by the administration of bismuth and opium. The utmost care in nursing and the toilet of the bed is of course required.

The *preliminary disinfection of the field of operation* is carried out the night before by the free use of ethereal soap, turpentine (which is applied with a soft nail-brush), an alcoholic solution of mercuric chloride or iodide (1 in 500), and finally an aqueous solution compress of the same strength; but in these matters each surgeon will follow his usual routine.

Movement and position of the patient. These details having been attended to the night before operation, it is convenient to bring the patient's bed to the side of the table by means of a bed-trolley, the use of a stretcher or couch involving an additional amount of disturbance which in traumatic and some tuberculous cases may be attended with serious consequences. Bed-trolleys, although little used in British hospitals, obviate much unnecessary disturbance, and will be found highly convenient in nearly all surgical work, but especially in laminectomy. Anæsthesia is now commenced in the bed, and when consciousness is abolished the patient can readily be lifted over on to the table, where he lies face downwards. During this preliminary anæsthesia the table is carefully prepared, as it is essential that the patient should occupy the prone position and should have ample room for abdominal respiration, especially in cases in which the intercostal muscles are paralysed. For this purpose a large firm sand-pillow is placed at the level of the pubes and iliac spines; a second lies under the upper chest and must be kept well below the upper margin of the sternum so as not to press upon the trachea; a third smaller cushion is adjusted to the position of the forehead. These cushions being carefully placed so as to suit the height of the patient, he is rolled over on to them, and the mouth, throat, and abdomen will then be found to be quite free from pressure. In a few cases in which the lesion lies high in the cervical region and is lateralized, the fully prone position

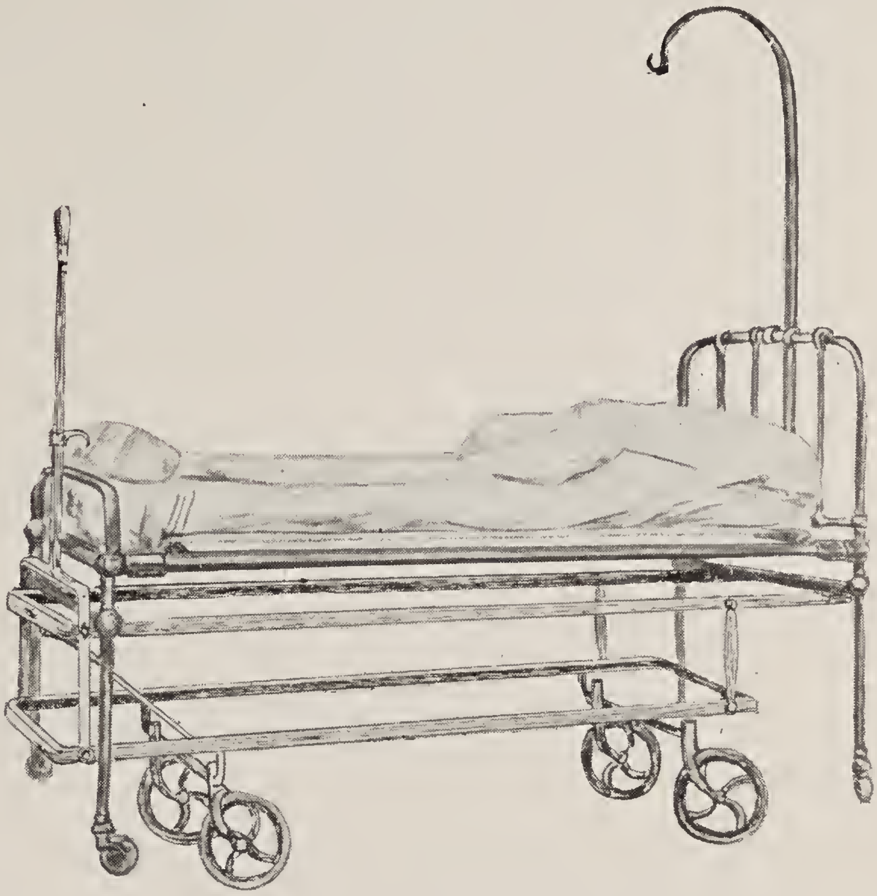

FIG. 239. BED-TROLLEY IN POSITION FOR CARRYING THE BED.

may be modified, and the pillows adjusted so that the patient lies semi-prone, thus giving the maximum of freedom to a probably embarrassed respiration, and allowing of more complete fixation of the head and neck. In this way I have been able to operate under full anæsthesia even when the diaphragm was so far paralysed that no abdominal respiratory movements could be detected.

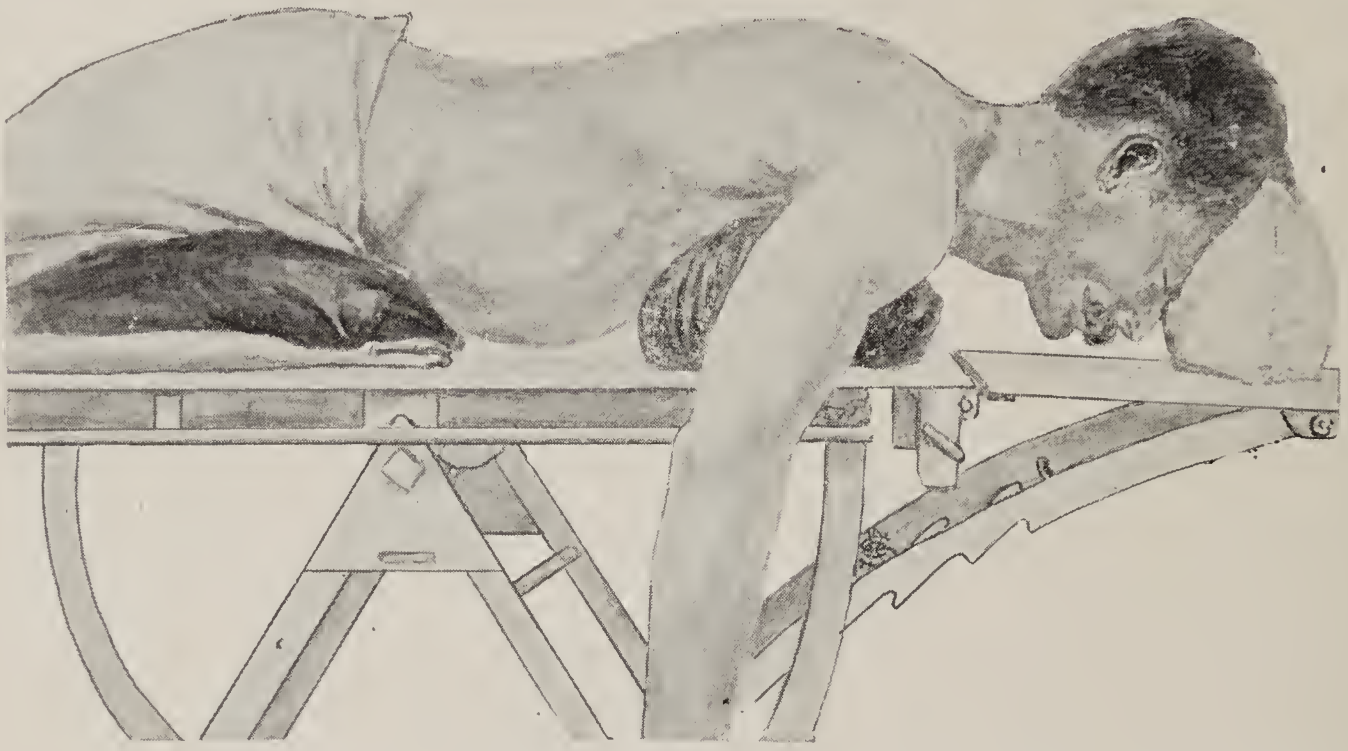

Fig. 240. Attitude for Laminectomy in the Dorsal and Lumbar Regions. The arms would rest upon the table, but are here drawn hanging down to show the space allowed for respiration.

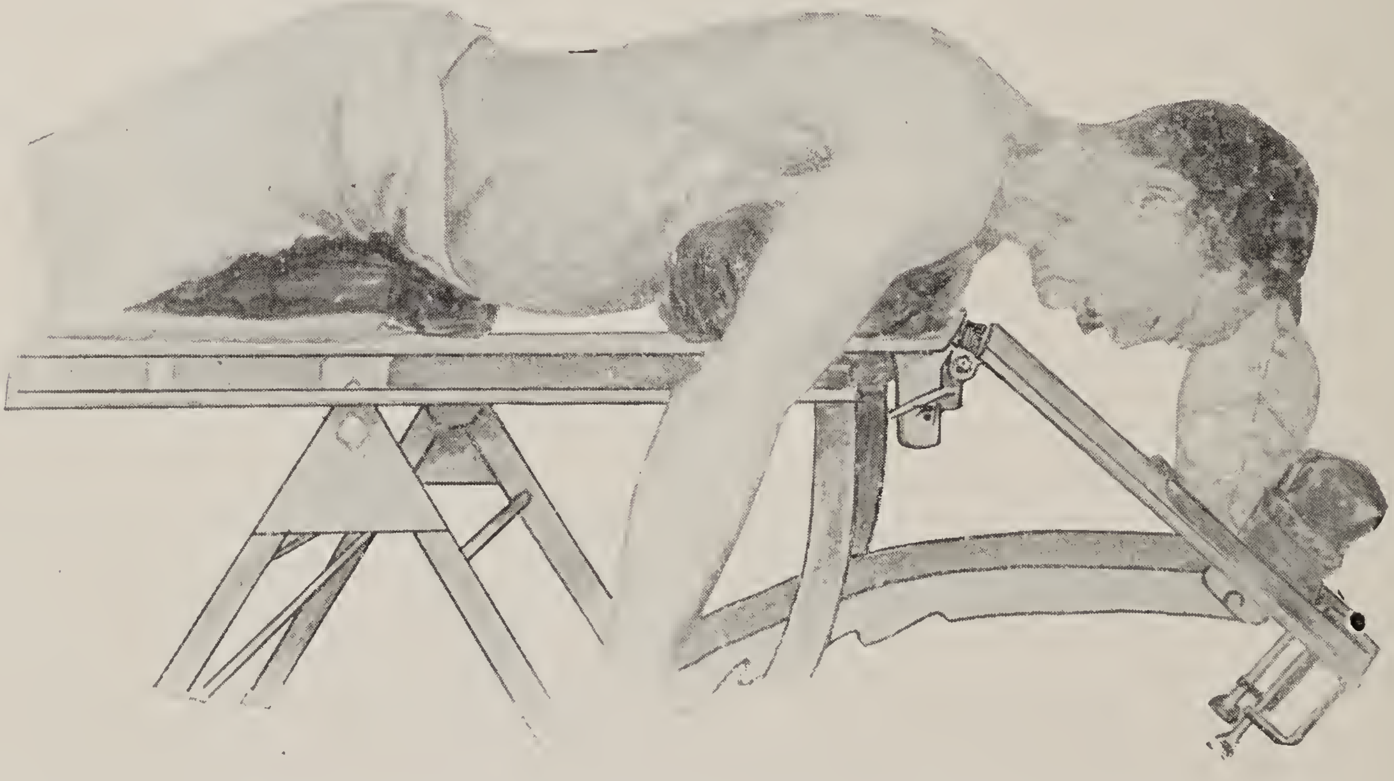

Fig. 241. Attitude for Laminectomy in the Cervical Region. The neck is flexed more fully than in the previous figure. The arms should rest upon the table.

Anæsthesia. General anæsthesia will probably be adopted in nearly all cases, as the operative manipulations are necessarily severe, but in some cases of 'two-stage' operations the second stage has been performed without an anæsthetic, the dura mater being but little painful on section (Abbé), and Fisher has twice operated under cocaine in cases of fracture in which the administration of a general anæsthetic was feared. Chloroform appears to me to be undoubtedly the most convenient anæsthetic, as no large face apparatus can be used with the patient in the prone position, and pieces of lint are much more readily manipulated. Of late I have also used oxygen when required, the tube from the cylinder being easily brought to the patient's face; or the Roth-Dräger apparatus may be employed. The anæsthetist should be experienced, and may have to face the most serious difficulties: respiration is often greatly embarrassed by paralysis, and there may be extensive bronchitis: the face is only partially visible: the pupils are difficult to see, and, in cervical cases, may present persistent contraction due to paralysis of the dilator iridis: where there is much bleeding or where much lotion is used, even drowning has to be guarded against: the anæsthesia must also be deep until after the removal of all bone. Under these circumstances it is not perhaps surprising that several cases have died from the anæsthetic.

Final preparation of the field of operation. The patient being now securely placed upon the table and its cushions, the dressing over the bed-sore, if present, is inspected to ascertain that it is clean and not displaced, and the compress is then removed from the field of operation. The latter area is then again cleaned with turpentine and an alcoholic followed by an aqueous solution of mercuric iodide or chloride. Small suppurating follicles are often present, and are touched with the Paquelin or other cautery. Finally, the back is covered by a dry sterilized sheet having an aperture over the seat of operation, and it is convenient to secure this in position by sutures passed through the sheet and through the skin of the back at the corners of the aperture.

Instruments required. The instruments are of great importance, and should be strong and well made, it being quite impossible to operate easily unless bone forceps and the like are well suited to the purpose. For dividing skin and muscles we require a strong large-bladed knife, resembling a post-mortem knife rather than the ordinary scalpel, and allowing of powerful sweeping through muscles down to bone; for the deeper incisions it is convenient to use a square-ended resection knife which can be firmly applied without any risk of penetrating between the laminæ. A small very sharp tenotomy knife is required at a later stage. Half a dozen pairs of hæmostatic forceps will probably suffice. The retractors must be adapted to a deep wound, and two pairs will generally be required to give a full exposure. Strong scissors are required for dividing powerful ligaments, and fine 'iris scissors' are useful for cutting the theca or dividing nerve roots, the blades of these being set at an angle of about 135° to the handle. Dissecting forceps, fine toothed forceps for handling the dura mater, and two or three pairs of fenestrated artery forceps for holding the edges of the cut theca are also required, as well as strong sequestrum forceps for tearing away fragments of bone. For sawing, Horsley's saw (see Fig. 242) or Doyen's guarded saw (see Fig. 243) may be employed: in some of the 'osteoplastic' methods Gigli's saw is used, but in ordinary laminectomy it is not needed. The bone-cutting forceps should be of the prismatic type, and it is advisable to provide two straight pairs, one very large and powerful (see Fig. 244), and one smaller (see Fig. 245), as well as two pairs (see Fig. 246) specially devised by Horsley for cutting the laminæ in a deep wound, although I seldom use any but the straight ones. Powerful rongeur forceps are also invaluable for enlarging the aperture in the laminæ. The trephine I do not employ, although some surgeons utilize it to make the first opening into the vertebral canal. One or two strong raspatories are needed for clearing the bone, and a chisel is also very useful for scraping off the soft structures and leaving a clean bony surface.

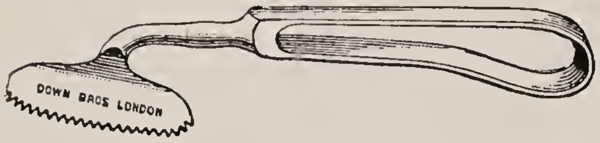

FIG. 242. HORSLEY'S LAMINECTOMY SAW.

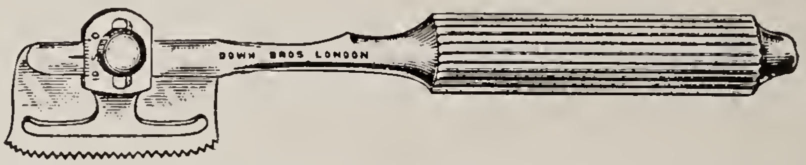

FIG. 243. DOYEN'S GUARDED SAW.

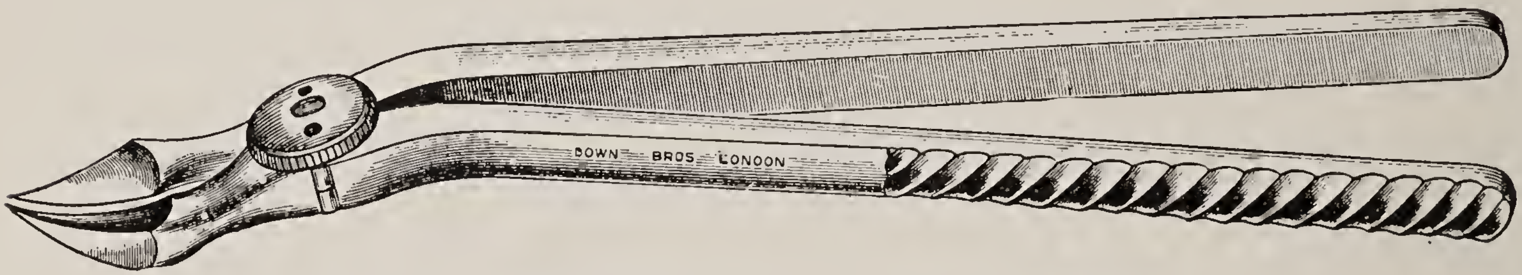

FIG. 244. POWERFUL BONE-CUTTING FORCEPS.

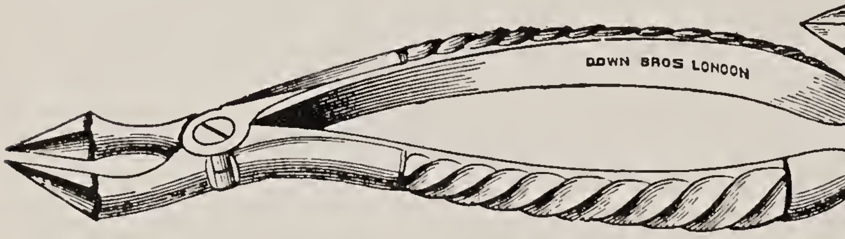

FIG. 245. BONE-CUTTING FORCEPS.

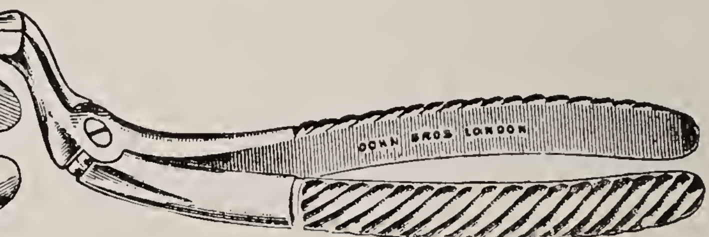

FIG. 246. HORSLEY'S ANGULAR BONE-CUTTING FORCEPS.

For the clearing of tuberculous foci, gouges, spoons, and Barker's flushing curette are employed, and a long probe is of value in determining the extent and direction of cavities. For enucleating tumours, some form of 'blunt dissector' is required, and Horsley's aneurysm needle is useful for this purpose as well as for holding aside the theca.

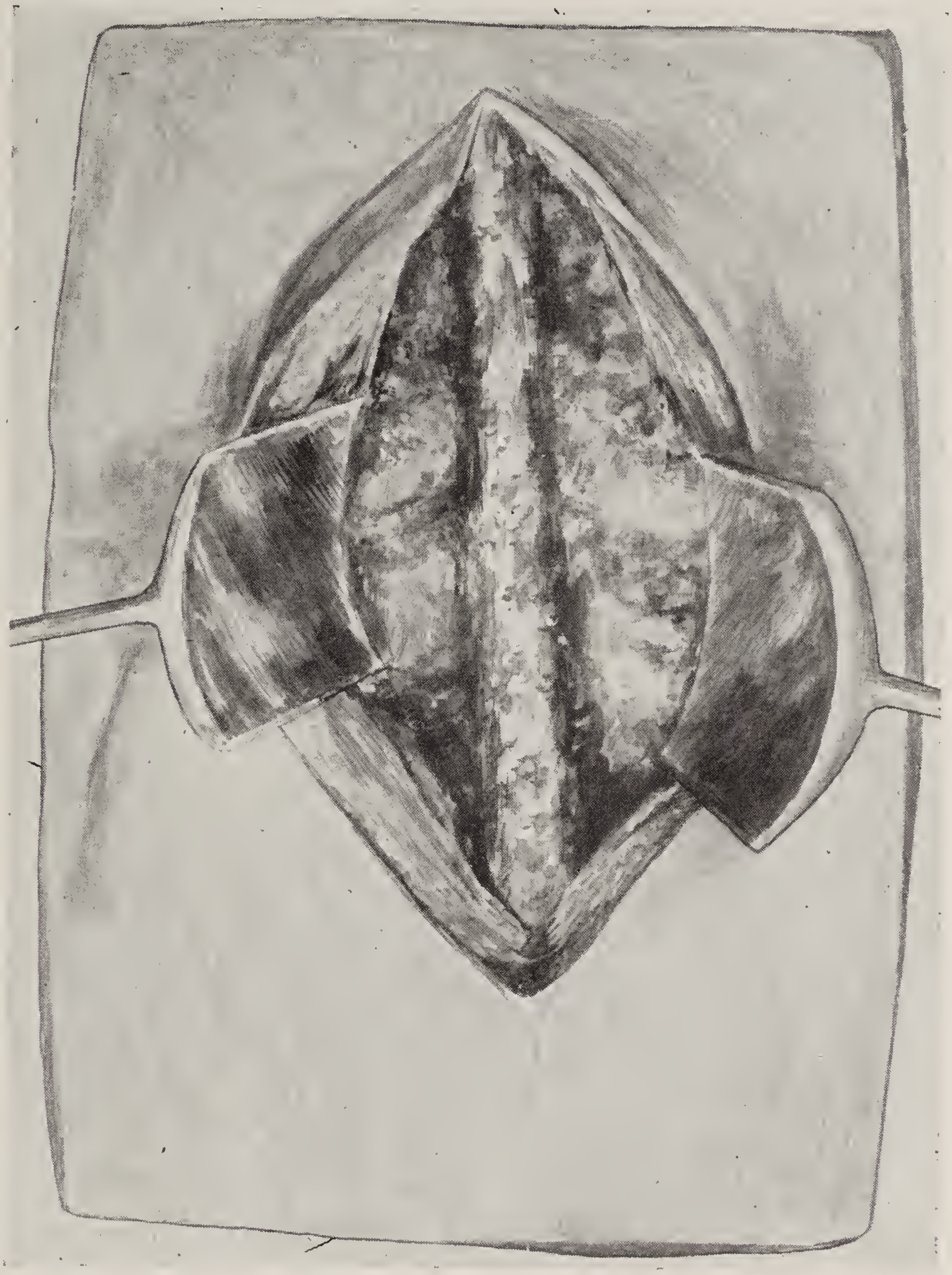

FIG. 247. LAMINECTOMY. *First stage.* Exposure of the ridge of spinous processes.

Small needles for the dura mater should be fully curved, Bonney's pattern being, in my opinion, the most convenient. I use large curved Bonney's needles for suturing muscles, and the ordinary straight surgical needle for the skin; others will prefer various patterns and possibly a needle-holder. All sutures, except silkworm-gut for the skin, are of catgut prepared according to the method of Mayo Robson or A. E. Johnson (*Lancet,* April 20, 1907), or otherwise effectually sterilized.

A douche containing a hot (115° F.) solution of 1 in 10,000 corrosive sublimate in normal saline is of great value for arresting bleeding, clearing the wound, and washing out tuberculous foci.

Operation. *Incision of the soft parts and clearing of the laminæ.* It is immaterial upon which side of the patient the surgeon stands, but the left will generally be preferred. The incision is made in the middle line of the back, and carried at once down to the spinous processes with firm strokes of the knife. It should be sufficiently long to give a full exposure of the parts, and will thus seldom be less than 6 inches in length, while subsequent developments may require it to be extended to 8 inches or more. The blade of the knife is now carried through the muscles close to the spinous processes on the side nearer to the surgeon, until its progress is interrupted by the laminæ, a few rapid sweeps separating the soft parts so as to make a deep groove on the left-hand side of the spine. No attempt should be made to deal with bleeding points, but, as soon as a considerable gap has been cut, swabs should be packed into the bleeding area and held down by the hands of an assistant. The further side of the spine is then cleared in the same rapid and as yet imperfect manner, and again the groove is packed with swabs. The hæmorrhage caused by these two deep incisions will, to large extent, cease in the course of about a minute.

We now return to the left side of the spine, the pressure by swabs being maintained upon the right, and clear the muscles more carefully from the spinous processes up to the extreme top and bottom of the incision. For this purpose a pair of strong scissors will be found convenient, and with a few cuts it will be possible to make the line of spinous processes and interspinous ligaments stand up as an isolated ridge (see Fig. 247). I have never found it necessary to make any transverse incisions in the muscles or fascia of the back, but I would insist on the importance of pushing the blades of the scissors so far upwards and downwards as to completely sever the soft parts from the spinous processes. The avoidance of any transverse incision causes less hæmorrhage, less interference with the blood-supply, and probably less subsequent weakening of the back. Swabs are again packed into the bleeding groove on the left side of the spine, and attention is turned to the right side, where the spinous processes are similarly cleared. At this stage large retractors can be introduced into the two grooves, and, the muscles being firmly drawn aside by assistants, the laminæ are well exposed. Should any large vessels continue to bleed, they may be secured by hæmostatic forceps.

Before going further, much more room is now obtained by cutting off in one mass the whole of the spinous processes. This is done with strong bone-cutting forceps, which are best applied so as to cut from above downwards, each spine being bitten through at its base and then forcibly wrenched off until the entire line can be turned down, as shown in Fig. 250. It is quite practicable to retain the ridge of spinous processes thus turned down, and to replace it at the end of the operation, but I have never seen any necessity for so doing, and there are certain obvious disadvantages and risks, especially in the case of tuberculous lesions.

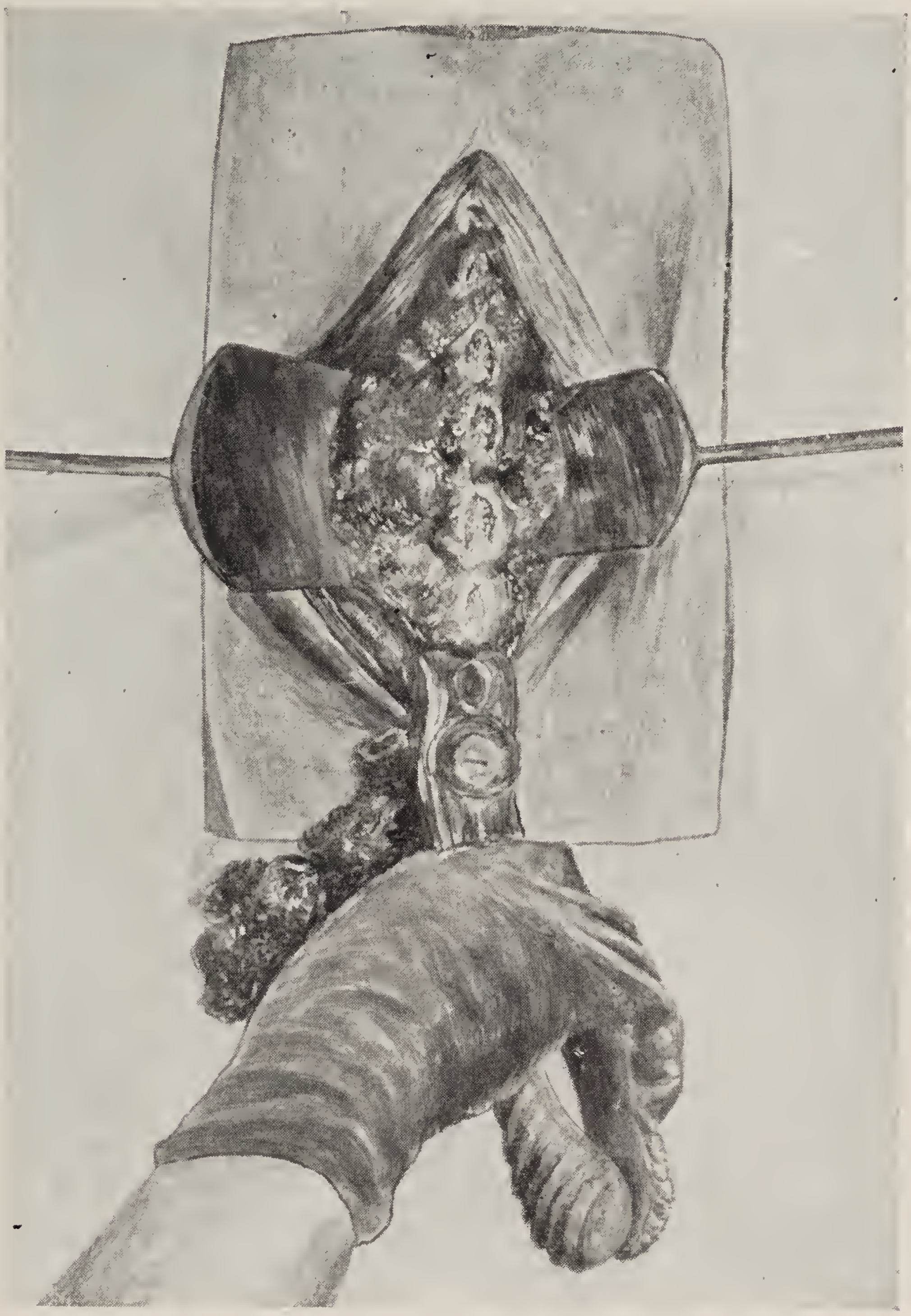

FIG. 248. LAMINECTOMY. *Second stage.* Removal of the spinous processes.

The laminæ which it is proposed to remove are now fully exposed, and the bleeding, which was at first somewhat profuse, will be to a large extent arrested. The next stage of the operation consists in cleaning the laminæ more accurately with a raspatory or chisel, arranging retractors so as to hold the wound well open, and removing any hæmostatic forceps. Ligature of vessels is rarely if ever required, and if oozing still continues the hot douche will aid in its arrest. In traumatic cases where there is recently effused blood, it is also important at this stage to express as far as possible any clots in the muscles of the back, and to make the wound as clean as possible. It is also useful to cover the sides of the wound with strips of gauze, leaving only the bottom of it exposed, but these strips are not represented in any of the drawings illustrating the operation, as they hide all but the bony structures.

The above detail is that which I generally employ, but it has been somewhat modified by various surgeons. Instead of a straight mesial incision a rectangular flap is sometimes employed, the vertical incision running down one side of the spine at about 2 inches from the middle line, while at either end a transverse incision some 4 inches long runs across the back. The parts thus marked out are raised from one side and thrown over to the other in the form of a flap, which may be made to include the spinous processes (Abbé), or may be limited to the superficial structures only, the muscles being subsequently cleared as when the straight incision is used. Some operators prefer a rounded flap turned upwards or downwards. I cannot, however, recommend these variations, except in special cases, which will be referred to immediately. They involve more damage to the muscular and fibrous structures than does the straight incision, and especially they involve transverse section of muscular fibres, unless the flap be restricted to the superficial structures. They also present the great disadvantage that it is difficult, if not impossible, to extend the wound upwards or downwards. I therefore generally prefer the vertical incision except in some tuberculous cases with marked kyphosis, in which it is convenient to commence the incision in the middle line and carry it in a wide curve round the side of the projecting spines, returning to the middle line below. By this incision a slight flap with very broad base is raised from the skin and superficial structures only, the muscles being detached from the middle line on both sides as before.

In some operations upon the upper cervical vertebræ it is also convenient to employ a lateral or curved incision. In this region the lesion to be dealt with is often situated laterally, and before commencing the operation its position is known so precisely that the laminæ of one side only may require removal. It is also more difficult to reach the upper cervical area by a mesial incision, and this cannot be carried forwards over the occipital bone to the required depth. In such cases it is useful to employ a somewhat sickle-shaped incision, taking the form of a vertical cut 1 or 2 inches from the middle line, extending upwards until it meets the occipital region of the skull, and then curving over the occipital bone across the middle line. This allows the short thick muscles of the back of the neck to be thoroughly reflected from the affected side.

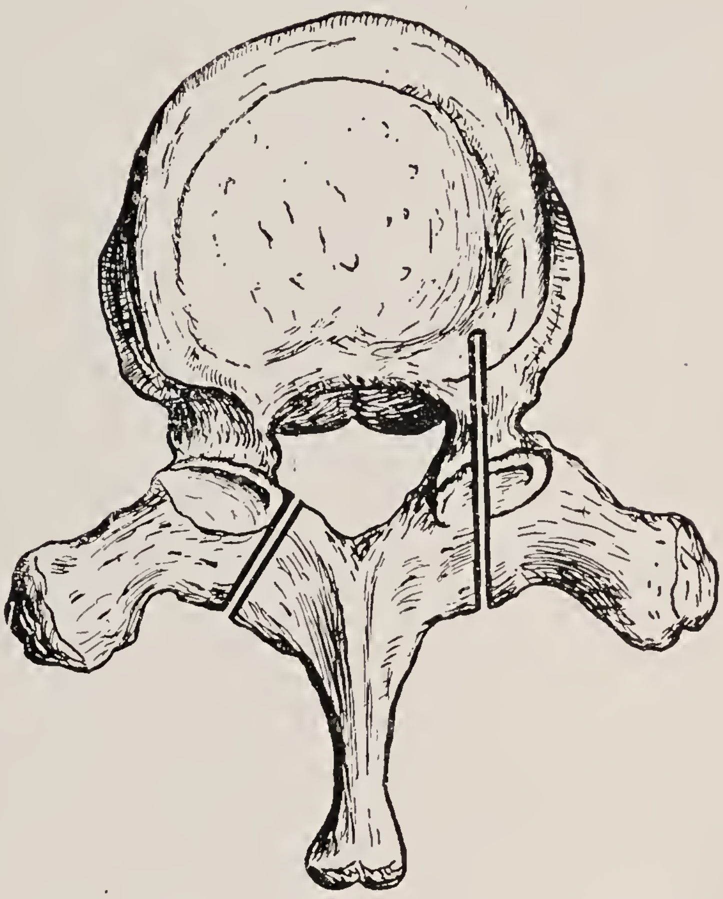

Fig. 249. Diagram of a Correct and Incorrect Line of Section of the Laminæ. (*Modified from Bickham.*)

Lastly, it is frequently advised that the soft parts should be reflected from the spine 'subperiosteally,' and Ollier gives elaborate directions for this purpose. Bickham (*Annals of Surgery,* March, 1905) recommends the chisel held with its bevel towards the bones as best adapted for raising the muscles with as much periosteum as can be obtained, but it is doubtful whether any truly subperiosteal clearing of the bone is here possible, and the method above described undoubtedly yields a sufficiently firm cicatrix.

Removal of the laminæ. The laminæ to be removed having now been thoroughly cleared by the raspatory, and all superficial bleeding controlled, while the parts are well retracted, the next step is to divide the bony arches by means of the saw. For this purpose Horsley's saw is applied to the outer side of the centre of the laminæ, and the cut is carried downwards and inwards until the laminæ are almost completely divided, or the lack of resistance shows that the spinal canal has been already entered. It is most important that the section should not be made vertically, as, if the saw is sufficiently far out in the first instance, and the cut is then made vertical, the vertebral canal will be missed altogether, and the incision will run forwards through the pedicle into the body of the vertebra, as on the right side of Fig. 249; if, on the other hand, the saw be placed at right angles to the axis of the lamina, it will penetrate towards the vertebral canal, as on the left side of Fig. 249. This preliminary sawing is easily effected in the dorsal region, when the convexity of the spine renders all the laminæ prominent. In the lumbar spine it presents greater difficulties, and it is here convenient if the surgeon can use either hand, or if the assistant is capable of sawing those laminæ which, owing to the deep concavity of the bony surface, cannot well be attacked from the left side of the patient. In the upper cervical region it is also somewhat difficult to apply the saw, but here the laminæ are so thin that they can be readily cut through by bone forceps alone, a method which is simpler and more rapid than that of sawing. In all cases in which the saw is used it is inevitable that a shallow groove should be cut in the laminæ above and below those to be removed, but this is of no practical importance.

Having made the preliminary saw-cuts, which will have penetrated to the vertebral canal, or nearly so, the bone-cutting forceps are now applied to each lamina in turn, and their division is completed, it being seldom necessary in the first instance to divide more than two. The points of the forceps should be carefully introduced for a short distance only on each side of the lamina, and should then be brought together and used to lever the bone upwards. This requires care, but the surgeon need be under no great apprehension that he will injure the theca, as there is normally a considerable space between it and the laminæ, and in disease this space will probably still be present, or, if absent, will be occupied by tuberculous tissue or tumour only. It is thus only in severe injuries and cases of caries with marked kyphosis that there is any probability of close contact between the bones and the dura mater. In traumatic conditions the lower of the two displaced laminæ should be first removed, as it is remote from the theca, which may be tightly compressed by the lamina above.

The section of the laminæ does not at once allow their removal, as they are still held by the strong ligamenta subflava, which have to be cut through with stout scissors, when the arch can be torn away by sequestrum forceps. An opening having once been made into the vertebral canal, it can, if necessary, be extended upwards or downwards by the bone-cutting forceps, and its edges are rounded off, or its area enlarged by rongeur forceps. The vertebral canal is thus fully laid open, and the further operative procedures which may be required will vary with the nature of the case, so that it becomes necessary now to consider separately—

(i) The treatment of traumatic conditions.

(ii) The treatment of tuberculous lesions.

(iii) The treatment of tumours and other compressing conditions which may or may not lie internal to the dura mater.

Treatment of traumatic conditions. The first step after having opened the vertebral canal will be the removal of any effused blood, the hot douche being used for fluid extravasation, while firm coagula are picked off or lightly scraped away by any blunt instrument. The exact nature of the injury will now be ascertained, small fragments of bone or foreign bodies being removed and tears in the dura sought for; it will also be noted whether the theca does or does not present its normal pulsation, colour, and tension. Should the latter not be torn, it is generally advisable to complete any operation upon the bony structures before opening it. The lamina which was pressing upon the posterior surface of the cord, as well as any detached fragments which may be discovered, will already have been removed. There is, however, a strong probability that the posterior part of the body of

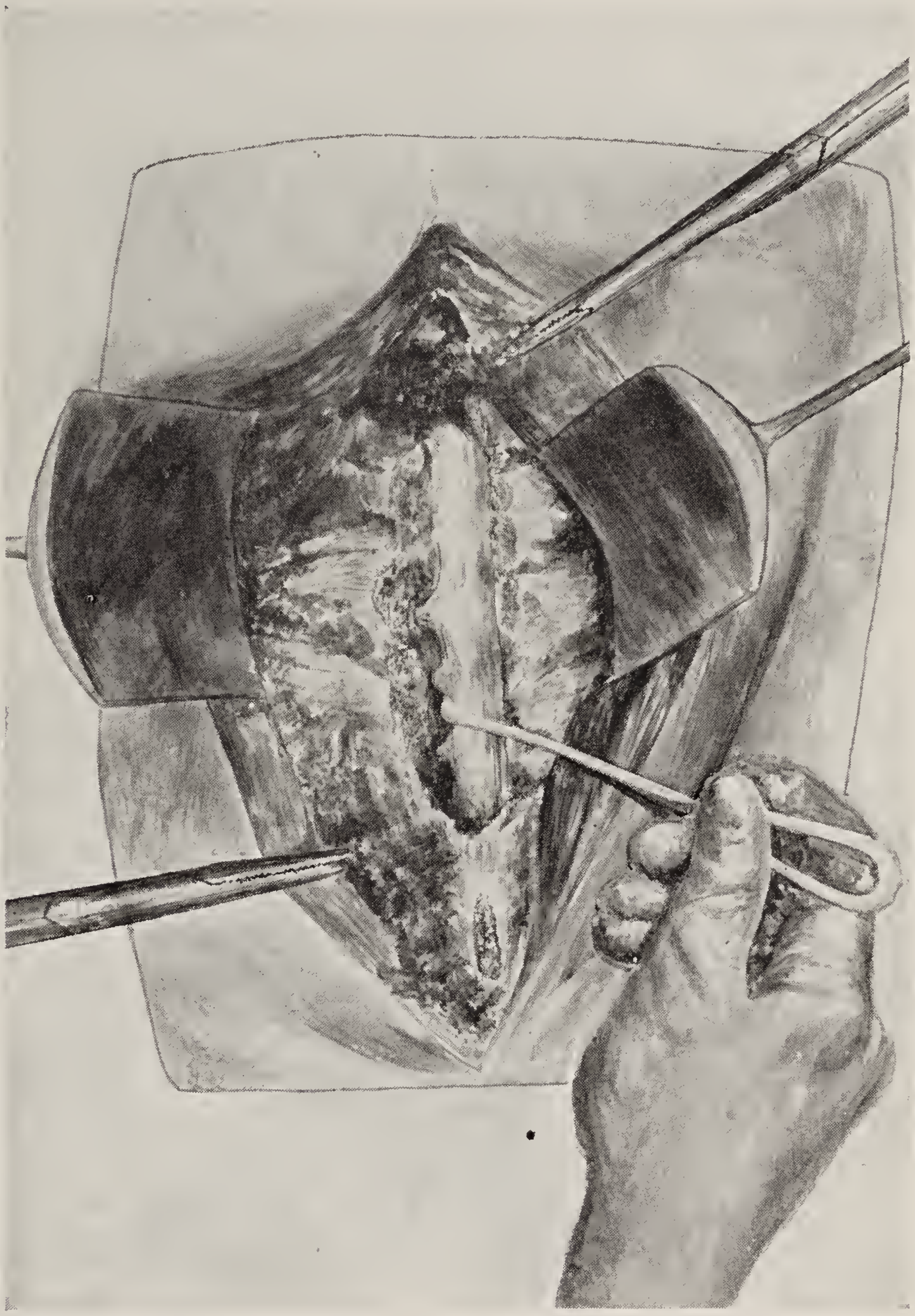

Fig. 250. Laminectomy. Exposure and retraction of the theca by Horsley's aneurysm needle.

the lower vertebra will be pressed backwards against the theca, and in order to restore the full capacity of the vertebral canal this must also be removed. To do so the theca is gently raised from one side,

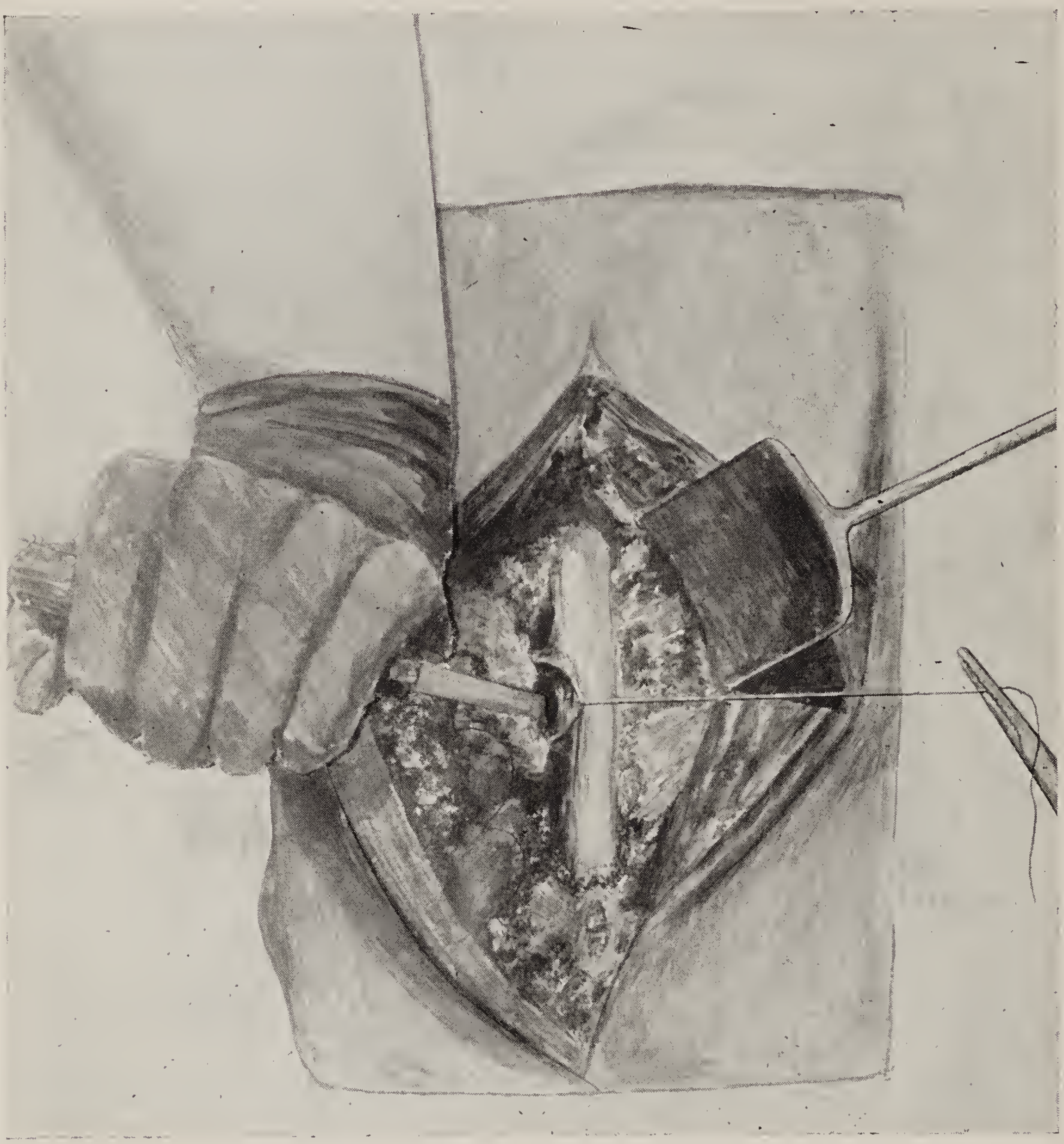

Fig. 251. Laminectomy. The exposed theca is retracted by a suture passed through it, and the chisel is applied to the body of the vertebra.

a convenient instrument for the purpose being a curved Horsley's aneurysm needle, as shown in Fig. 250, or a fine suture passed through the dura mater only, as in Fig. 251. In some cases it has been found necessary to divide one or two nerve roots so as to permit of still further retraction of the theca, and in the dorsal region this may certainly be done with little hesitation, the cut fibres being afterwards sutured with fine catgut. By one or other of these means the dura can be raised up, and the projecting angle of bone clearly exposed and cut away by means of a sharp chisel, after which the same proceeding is repeated on the opposite side, and any projection completely removed.

The lumen of the vertebral canal being now fully restored, it remains to deal with the theca and its contents. If the former be already torn open, it is not probable that it will contain any large amount of blood; if it be still closed, it must be opened by a free incision in the middle line, when any extravasation can be washed away by the douche. For the purpose of the incision in the theca the most convenient instruments are a fine tenotomy knife or cataract knife, a pair of fine toothed forceps, and a pair of iris scissors. The theca is lightly picked up, the point of the knife being introduced into it, and the section then completed by cutting with scissors, very much as in opening the peritoneum, except that, of course, the instruments required are much smaller, and ought to be very sharp.

The spinal cord itself, or its roots, are next investigated, and may be found intact, in which case nothing further need be done; or, more often, the nervous structures will be so crushed as to form a blood-stained pulp which cannot be dealt with surgically; or, very rarely, we may find a clean cut produced by a stabbing instrument. In the latter case suture has been adopted, as in the cases of Harte and Stewart and of Fowler (*vide supra*), in which chromic gut sutures were passed through the substance of the cord. Such suture should certainly be attempted, and the torn dura should, if possible, be brought together; but it is difficult to justify the excision of a bruised segment of the cord, as experience clearly shows that functional recovery may ensue even after severe bruising, while, on the existing evidence, no great confidence can be felt in suture. Abbé quotes with approval a suggestion made to him by Dana, and subsequently also recommended by Lloyd, to the effect that gaps in the medulla should be bridged over by cutting across the posterior roots of the upper segment and uniting their cut ends to the lower segment; but such an operation does not appear to have been actually practised, and there is no evidence whatever that function would be restored by it. Should the cut involve the roots of the cauda equina there is, however, no doubt as to the value and importance of suture, and successful cases have already been referred to.

The different conditions which may be encountered having thus been met, it remains only to reclose the theca and the wound, as will be described hereafter.

In *secondary operation* for old injury, it may be discovered, upon opening the spine, that the theca is firm, contracted, and devoid of pulsation; on incising the dura mater the injured region of the cord is revealed as a thin, firm band of pale tissue, which apparently contains few or no nervous elements, and which, looking like a quill, may be an inch or more in length. Under these conditions nothing further can be done. In some cases, however, a mass of callus may be found pressing upon the theca, or a dense mass of cicatrix may occupy the peridural space, and in these the compressing agent must be excised, the prospects of recovery being much more favourable.

The treatment of tuberculosis. When the laminæ have been removed, it will often be found that the vertebral canal is occupied by a large amount of tuberculous tissue, which may be in any stage of degeneration, and it is important to notice that puriform fluid may at once escape when the laminæ are cut, and may at first sight be mistaken for broken-down nervous structure. Such a tuberculous mass, if present, renders it easy to remove the laminæ quickly and thoroughly, without danger of the instruments impinging upon the theca; but in case of marked kyphosis the perimeningeal space may be greatly contracted, and the theca may be pressed against the laminæ as closely as in traumatic cases. The first step after the exposure of the tuberculous material will be to remove it as thoroughly as possible, and for this purpose the opening into the vertebral canal may require to be considerably extended upwards or downwards. Puriform and caseous matter can be washed away by the douche, while more solid tissue is scraped off by a small Volkmann's spoon or other blunt instrument. In many cases, especially in those of old standing, there is discovered a definite leathery mass of cicatricial fibrous tissue which may have to be excised by means of the knife and fine scissors; but in all, or nearly all, it will be found comparatively easy by ordinary surgical methods to get rid of the whole of the diseased material which lies behind and to the side of the theca, and thoroughly to clean its firm, shining, and still healthy-looking outer aspect.

It is, however, essential also to investigate and clear the anterior aspect of the dura mater. The latter is held over to one side by the aneurysm needle, as in Fig. 250, but in tuberculous disease a suture should never be used for this purpose, as it is essential not to infect the interior of the dura. Tuberculous material can now be removed from the front of the theca, as has already been done on its posterior aspect, and in many cases one or more tracts will be found to lead forwards into the bodies of the vertebræ. These tracts must be thoroughly curetted with sharp spoons, and too much care can hardly be given to this task. The abscesses or carious areas may extend far forwards, and may even be continuous with large cavities in the posterior mediastinum or abdomen. Should the conditions be such that these collections can be opened and dealt with by some route other than that which leads through the vertebral canal, such secondary evacuation is to be preferred, but where this is impracticable all that can be done is to eliminate as much as possible of the diseased material by the opening already made. One side of the theca having thus been thoroughly cleaned, the other is similarly dealt with, but it will generally be found that the disease is much more extensive upon one side, and, fortunately, the pushing aside of the cord by exudation generally leaves a maximum amount of room upon the affected side. Throughout this stage of the operation the frequent or constant use of the douche is invaluable, and it is essential to wash away any débris which may have been scraped from the deepest parts of the wound.

The use of a drainage tube passing through the vertebral canal is not to be recommended even in the case of deeply seated and extensive foci. In a few early cases I employed such drainage, taking the greatest care to ensure that, when left in position, the tube did not press upon the spinal cord; but I am quite satisfied that it is wiser to complete the curetting and flushing of the abscesses as thoroughly as possible, and then to close the wound.

The dura mater should never be opened in tuberculous cases, as it forms a very efficient barrier to the extension of the disease to the meninges, and the destruction of this barrier can only do harm, while in the rare cases in which infection has already penetrated to the spinal cord the condition is beyond the reach of surgery.

Treatment of tumours and similar conditions. If the exposure or removal of the laminæ reveals a growth originating in bone, it will probably be malignant, and in such cases all that can be done is to partially excise or scrape it away by means similar to those adopted in the case of tubercle. I have done this on two or three occasions, and obtained very good results so far as the immediate relief of pressure symptoms is concerned, but naturally the total removal of the malignant growth has not been possible, and the patients have ultimately died from one or other of the varied results of such disease.

Non-malignant tumours in the vertebral canal, including such conditions as hydatid cysts and the masses of fatty and other tissue met with in spina bifida occulta, are generally on the posterior aspect of the theca, and may be dissected away by ordinary surgical measures. In all such cases it is unnecessary to open the theca, but removal of the compressing mass should be carried out with great care and thoroughness, and, if pulsation is not then visible in the whole of the exposed area of the theca, an intrameningeal lesion may be suspected and sought for. The results of such operations are excellent, but the occasions for them comparatively few.

The most interesting cases are, however, those in which the growth lies within the theca. In many of these nothing will be discovered until the dura is opened, although a slight bulge may be perceptible externally, and pulsation may cease at the point where the growth is situated. An incision is therefore made in the middle line of the theca with the fine knife and scissors as already described, and this must be long enough to expose the whole of the affected area. It will be found convenient to keep open the lips of this incision by means of two fine sutures upon each side, passed through the cut edges and held back by the weight of Spencer Wells's forceps, as in Fig. 252. The tumour will then generally come into view, the majority being situated on one side of the spinal cord, and in a very accessible position, but it is to be noted that in a good many cases a cyst-like bulla of the arachnoid may first be revealed, and may be mistaken for a cyst or may overlie and obscure an actual tumour; such sacs or bullæ collapse at once on slight puncture. The tumour itself is seldom of great size, but forms a soft, rounded or oval, encapsuled mass of about the same colour and consistency as the cord itself, or darker and more vascular and often very friable. The little growth generally lies between two adjacent nerve roots, or it may involve one or even more roots in its substance, and it is seldom a difficult matter to enucleate it by gently insinuating round it the point

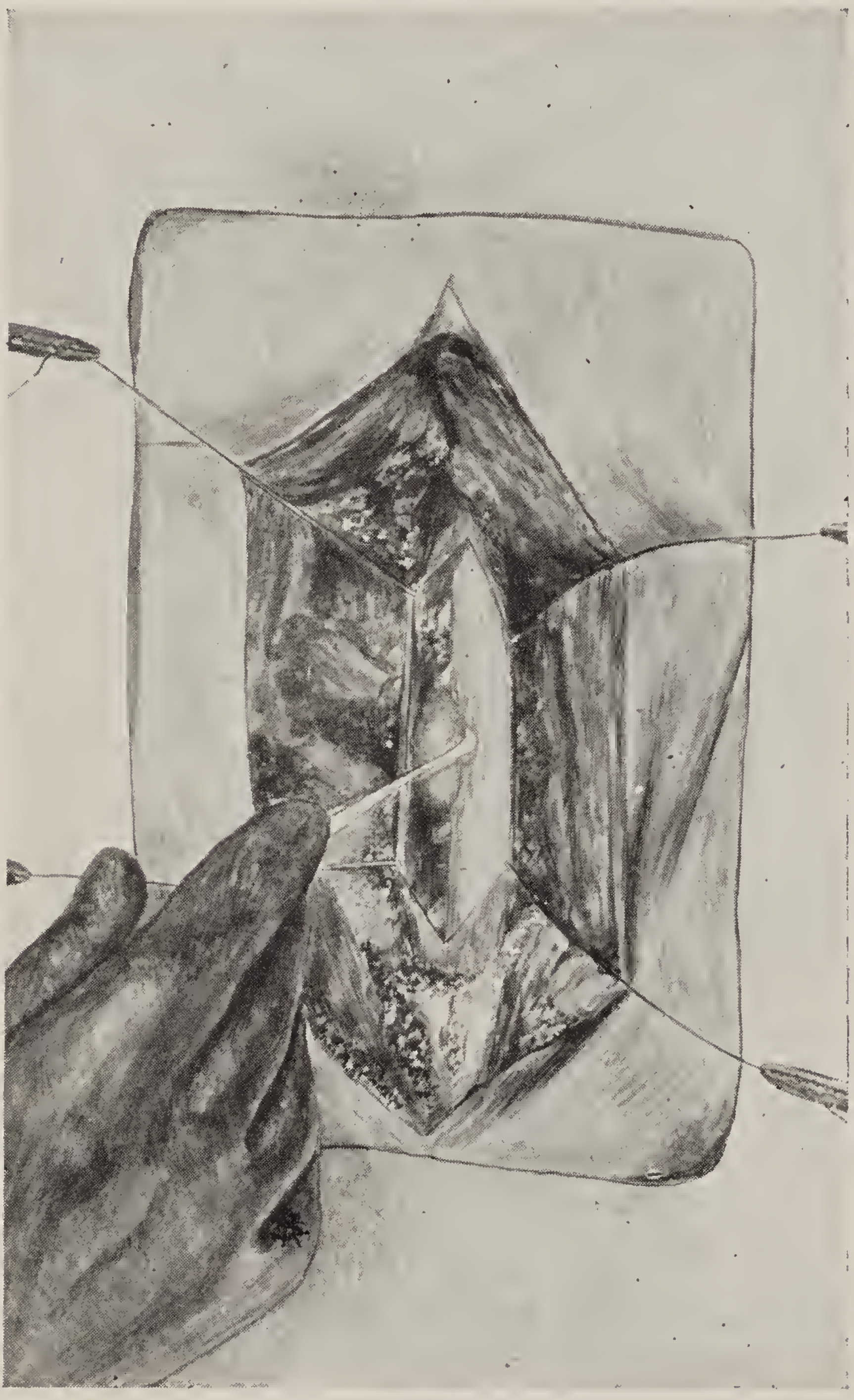

Fig. 252. Removal of an Intrameningeal Growth. The theca is held open by four sutures and the growth dissected away from the spinal cord.

of the curved aneurysm needle or other blunt dissector. If any roots be involved in the growth, or not readily separable from it, these may be cut across and excised without hesitation, especially as in the majority of cases they will be in the comparatively unimportant dorsal region.

Tumours situated in the substance of the cord are removed by the 'method of extension' of Elsberg and Bier as follows:

After aspirating the tumour with a fine hypodermic needle to rule out the possibility of a cyst or fluid tumour, the arachnoid is incised and grasped with a fine forceps. The proper part of the posterior column for incision is selected, depending on the level of the tumour. In the lumbo-sacral region an incision may be made anywhere in the posterior column, but is best made a few millimetres from the median line to avoid the descending tracts. In the dorsal and cervical regions the incision should be made in the posterior median column and the higher the level the nearer to the median line should the incision be placed; however, aiming if possible to incise the cord at a point where the tumour is nearest the surface. A small longitudinal incision is made with a von Graefe knife down to the tumour. This is extended to the limits of the tumour by separation of the fibres with a blunt hook, such as the strabismus hook. These manœuvres are done very slowly and stopped as soon as hæmorrhage occurs and halted until it has stopped. Sponging is done with extreme gentleness so as to exert no pressure on the cord. The operation is now completed with a suture of the muscles, fascia, and skin, leaving the dura open.

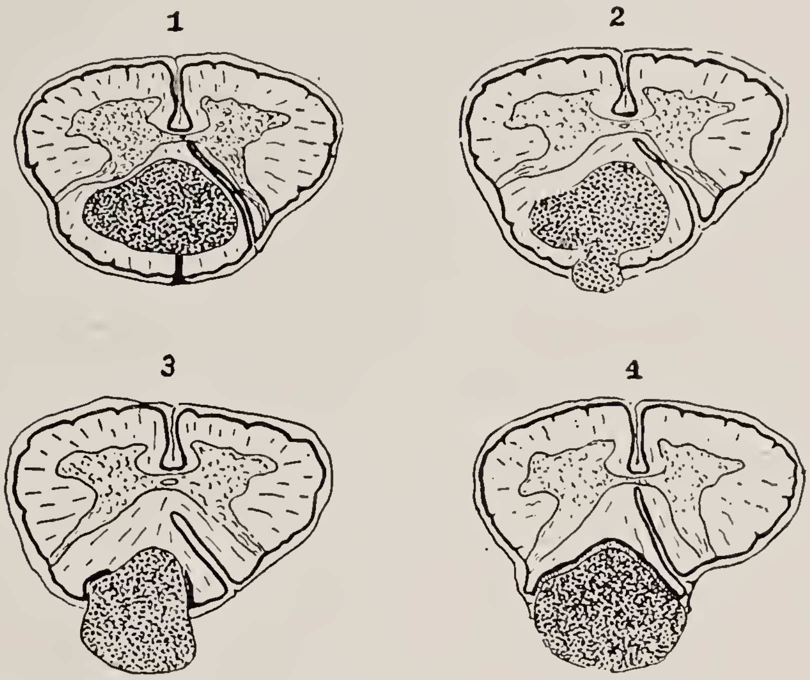

Fig. 253. Stages in the Extrusion of an Intramedullary Tumour (diagrammatic). (Elsberg, *Diseases of the Spinal Cord.*)

Symptoms of diffuse infiltrating growths may for a time be aggravated, but evidence of extrusion is usually presented by an improvement from the symptoms within a few days. In about one week or ten days the second step of the operation is done. The wound is reopened and the tumour, which is now probably entirely outside of the cord and attached only by a few adhesions, may be removed. At this time the dura is sutured as well as the muscles, fascia, and skin (see Figs. 253, 254, 255, 256).

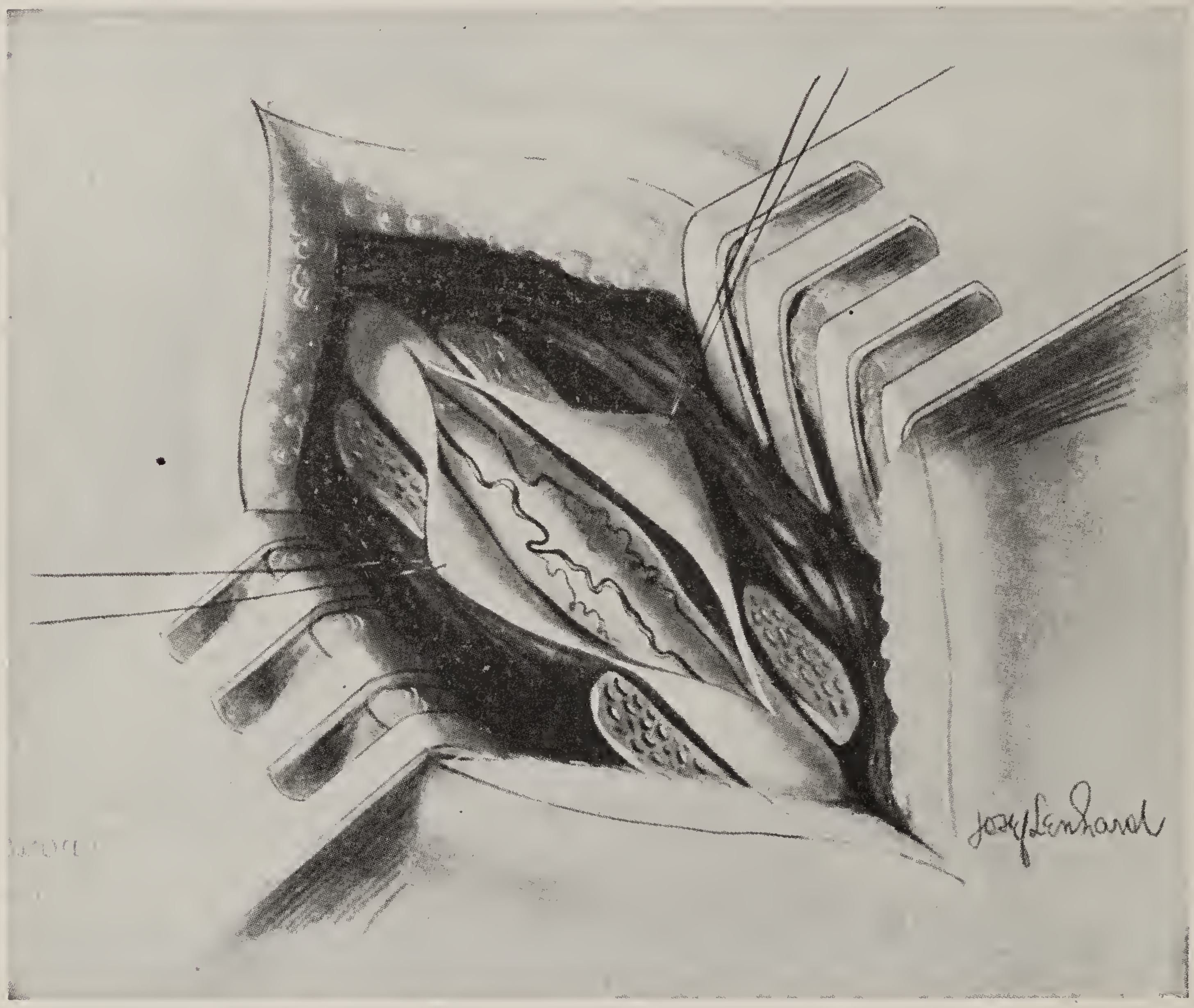

Fig. 254. An Intramedullary Tumour which caused a Fusiform Enlargement of the Cord. After incision of the cord and extrusion of the growth, the tumour was removed (see Figs. 255 and 256). (Elsberg, *Diseases of the Spinal Cord.*)

Closure of the wound. If the dura mater has been incised, it may be closed by a continuous suture of fine catgut, or preferably by interrupted sutures placed about ½ inch apart. The erectores spinæ of both sides are then approximated by a further series of interrupted catgut sutures, leaving the trapezius or latissimus dorsi still gaping, after which a third series of sutures brings the latter superficial muscles together and finally the skin is closed with silkworm-gut. I have not in recent years employed any drainage, and have never had any reason to regret this course.

The wound having been closed and covered with an amount of dressing sufficient to absorb any cerebro-spinal fluid which may escape, it may be necessary to apply immediately some form of support to the spine. In traumatic and in extensive tuberculous cases this should be prepared beforehand by cutting out to the model of the patient's back a piece of the strongest poroplastic felt: in the lower dorsal and lumbar region this is made to surround the body, and where the operation is cervical or upper dorsal it encloses the shoulders and should be brought forward over the clavicles or upwards on to the occiput. Such a carapace is laid over the dressing while the patient still remains in the prone position, and is temporarily retained by one or two turns of bandage. The patient is now carefully lifted back on to the bed, which, as before, is drawn to the side of the operating table, and the support is then more securely attached by a many-tailed or roller bandage;

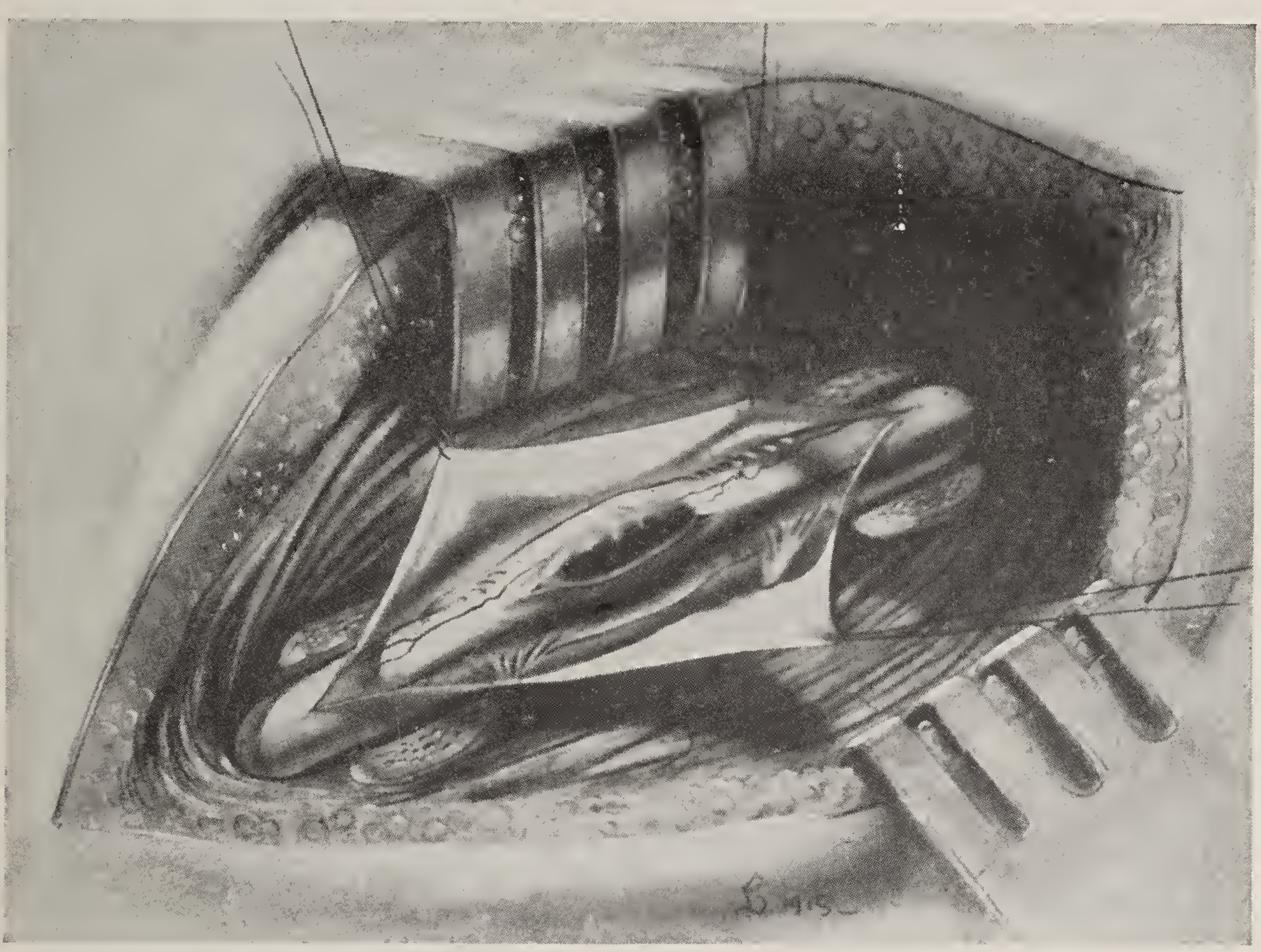

FIG. 255. REMOVAL OF AN INTRAMEDULLARY TUMOUR BY THE EXTRUSION METHOD. II. The cord has been incised and the growth is partly extruded. (Elsberg, *Diseases of the Spinal Cord.*)

finally, the head and shoulders are fixed by towels held in position by sand-bags.

In the great majority of cases the supine position in bed will prove the most satisfactory as well as the most comfortable, but where there is much removal of bone and any danger of pressure on the cord it is well to keep the patient upon his face.

After-treatment. In cases of prolonged operation there may be a considerable amount of shock, and for this reason many operators have divided the procedure into two stages. This is, however, very rarely necessary, and the advantages of immediate completion are obviously great. I have found little or no real difficulty in connexion with shock, and a few hours in a warm bed are usually followed by rapid recovery. Pain is often severe, but there is not as a rule any objection to the somewhat free administration of morphia. The wound is generally dressed at the end of a week, and will then be found healed. Profuse flow of cerebro-spinal fluid is an occasional inconvenience, but is certainly rare,

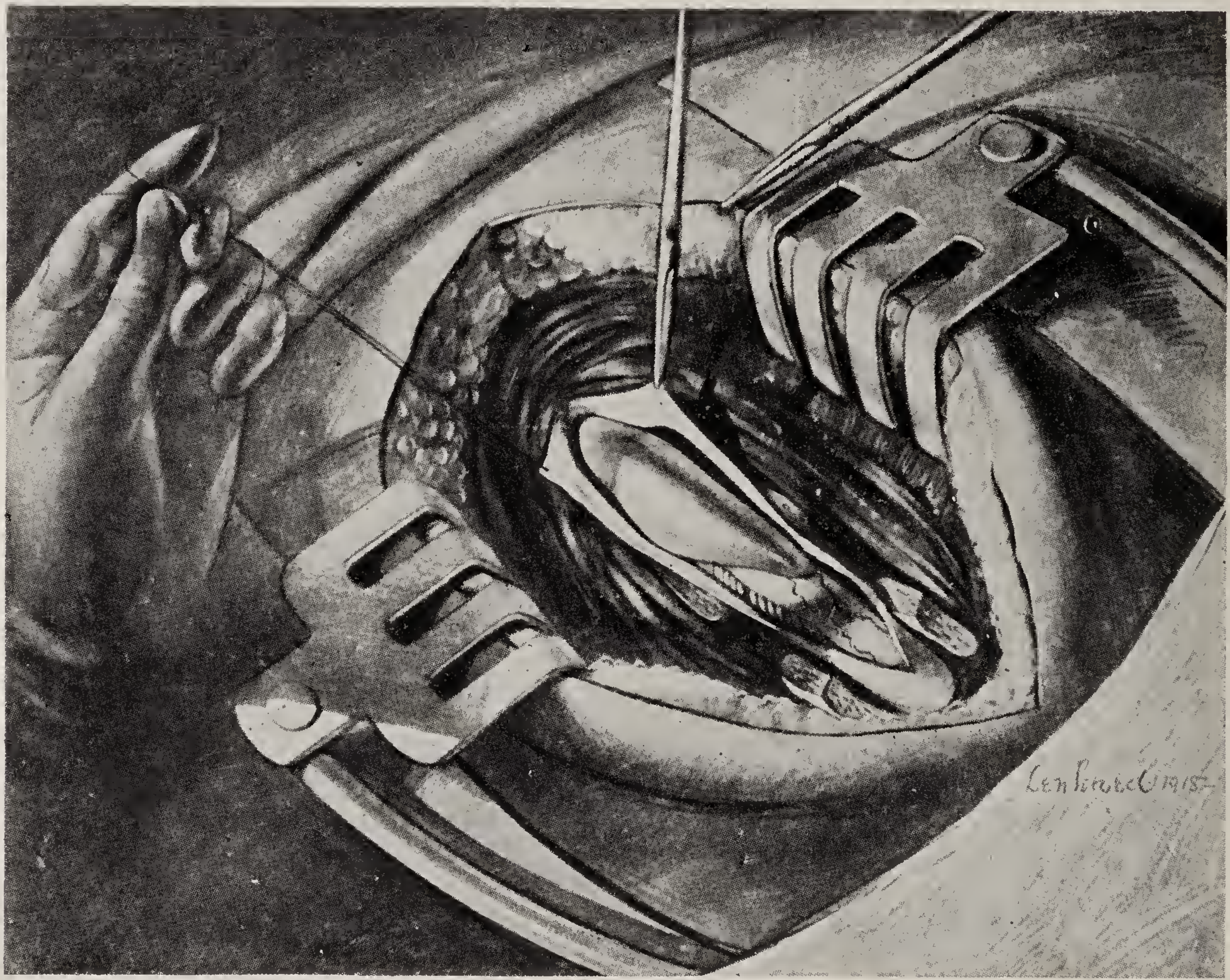

FIG. 256. REMOVAL OF AN INTRAMEDULLARY TUMOUR BY THE EXTRUSION METHOD. III. After one week the growth had been entirely extruded, and was easily removed. (Elsberg, *Diseases of the Spinal Cord.*)

although in some cases it appears to prolong the vomiting which follows anæsthesia; it may be controlled to some extent by keeping the head low and raising the foot of the bed, and it may call for dressing at an earlier date than would otherwise be required; vomiting due to this cause being probably best relieved by bromide of potassium. Details of nursing will be governed by the general conditions as regards paralysis, bedsores, and affections of the bladder and rectum, while in some cases pulmonary complications, hyperpyrexia, and the like, may have to be dealt with; but, apart from troubles which are common to other cases of paraplegia, and are the result of the disease rather than of the operation, there is no essential difficulty in the after-treatment.

The surgical results are generally excellent, and wound healing is, as a rule, rapid and firm, the only serious difficulties being those which may result from tuberculous infection. In all ordinary cases confinement to bed for about a month will suffice, and at the end of that time the back will be sufficiently strong for the patient to sit or stand up; but in tuberculous disease special supports may be required, and in all cases the therapeutics of paralysis or of secondary deformities, such as talipes equinus, must be carefully attended to.

MORTALITY AND DANGERS

The accompanying analysis of 120 laminectomies performed by Elsberg and published in his book on *Diseases of the Spinal Cord and its Membranes* gives one a view of what may be expected when doing this operation for all conditions.

Before undertaking the operation of laminectomy one should have thoroughly familiarized himself with the surgical anatomy of the region by a careful study of dissections. The condition for which the operation is done modifies the mortality, but beyond this the operative risk varies inversely with the experience of the surgeon.

The upper cervical region because of its proximity to the medulla and origin of the phrenic nerve from the fourth cervical segment is more dangerous than the lower segments. Respiratory embarrassment may suddenly occur, in which case intratracheal insufflation of air and oxygen or other methods of artificial respiration should be resorted to. The laminæ of this region because of the small bodies furnish some support to the spinal column and as few of them as possible should be removed.

There are certain special difficulties and dangers which demand somewhat further consideration.

TABLE OF RESULTS IN 120 LAMINECTOMIES.[1]

Total operative mortality 8.3%, excluding acute softening and recent fractures with complete crush of the cord, 4.2%.

Laminectomy for	No. of cases	Recovered from operation	Cured or almost cured	Markedly improved	Little or no improvement	Died	Died within one year	Total
Spina bifida occulta	2	2		2				2
Abnormal spinal vessels	5	5	2	3				5
Recent fracture of spine	3	1		1		2		3
Old fracture of spine	5	5	2	3				5
Tumour, extradural removed	3	3	2	1				3
Tumour, extramedullary removed	13	13	9	4				13
Tumour, intramedullary removed	9	8	2	4	2	1		9
Tumour, intramedullary not removed	7	6		2	4	1	3	7
Tumour of conus and cauda	4	4		2	2		2	4
Tumour, multiple sarcoma	1	1			1		1	1
Tumour, sarcoma of vertebræ	6	4		2	2	2	2	6
Tumour, metastatic	2	2			2		2	2
Aneurism of spinal vessels	1	1			1			1
Exploration	10	10		3	7		3	10
Exploration, acute softening	3					3		3
Syringomyelia, hæmatomyelia	4	4		2	2			4
Neuritis of cauda equina	5	5	2	3				5
Pachymeningitis	3	3	1	2				3
Acute osteomyelitis	2	1	1			1		2
Osteoarthritis	1	1	1					1
Spinal decompression	11	11	1	7	3			11
Spinal decompression, meningomyelitis	2	2		2				2
Division of posterior roots	17	17		13	4		3	17
Division of anterolateral tracts	1	1		1			1	1
	120	110	23	57	30	10	17	120

Shock is often severe, and is due mainly to the prolongation of the operation and to hæmorrhage. It is therefore best avoided by familiarity with the technique, the use of thoroughly suitable and reliable instruments and especially of effective bone-cutting instruments, the efficient arrest of bleeding, and care in the warming of the operating theatre and in protection of the body temperature by wrapping up the limbs. The division of the operation into two stages offers much less advantage than in operations upon the skull. In cases of injury such division will rarely be contemplated, as the conditions are comparatively simple, the localization is easy, the treatment of the bony lesion is usually the sole consideration, and the only hope of success lies in the relief of the lesion at the earliest possible date. In the case of tumours also, the operation, if divided into two stages, would be interrupted before the incision of the theca, but this incision and the enucleation of a growth seldom take any great length of time or cause any serious hæmorrhage or shock. In tuberculous cases with extensive abscesses the difficulties and delays may be great, but unfortunately these cases are ill suited to a two-stage operation which increases the already grave risk of infecting the wound with tuberculosis. For these reasons I have never thought it wise to divide the operation. One of the two cases which died from shock was that of a child in which the removal of the laminæ revealed the fact that the bodies of the vertebræ were totally destroyed, so that all the support of the spine was withdrawn, and in the other a large abscess penetrated to the pleura, neither of which are conditions likely to have given better results had the operation been thus divided.

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[1] Table copied from Elsberg, C. A.: *Diseases of the Spinal Cord and its Membranes.* Philadelphia: Saunders, 1916.

As a rule, even severe shock after laminectomy passes away readily when the patient is returned to a warm bed. The usual stimulants may be given by the mouth or by hypodermic or intravenous injections, and there is no difficulty, such as is met with in abdominal operations, in giving food and stimulants by the mouth. On the other hand, it is advisable not to give rectal injections if they can be avoided, as the rectum is often incapable of retaining them, while there is considerable risk of soiling the dressings and it is advisable to disturb the patient as little as possible.

The *anæsthesia* presents very considerable difficulties, and in several reported cases death has resulted from the anæsthetic. This question has, however, already been fully dealt with, and it is only necessary to reiterate the importance of providing for the free use of such muscles of respiration as can act, and, in operations upon the upper spine, guarding against the entrance of fluid into the respiratory passages.

Hæmorrhage is very free at the time of incising the muscles of the back, and is naturally the most prominent danger at the moment of operation. The best safeguard is to make the incisions into muscle freely and quickly, and then to plug the wound with hot wet packs, allowing a short time for pressure to effect arrest. If this be done it will be found that after a very few minutes only one or two bleeding points remain, and that these can readily be secured. Flap operations and methods which involve any transverse section of the muscles of the back are obviously more liable to be associated with serious bleeding, for which reason the long straight incision of all muscles is probably much the safest. Chipault has collected three cases of death due to hæmorrhage from the vertebral artery, but such results appear to indicate a want of precision in anatomical knowledge, as, if the operation approaches the transverse processes of the cervical vertebræ, the artery ought to be tied. Secondary hæmorrhage appears to be unknown, and the position of the wound causes so much local pressure that we need probably have no fear of continued oozing.

Sepsis has seldom given trouble, and the measures which have been found most effective in its prevention have been already indicated. Von Bergmann advises stitching oiled silk to the edges of the skin wound, followed by re-sterilization of the hands before proceeding with the operation, but gauze is probably quite as effective and is much more efficient in arresting hæmorrhage.

Escape of cerebro-spinal fluid has in the past been regarded as a special danger of the operation, but does not appear to have been actually fatal in any case either of operation or of accidental injury to the meninges. If troublesome at the time of operation it may be controlled by lowering the patient's head, but the flow is rarely sufficiently profuse to cause any inconvenience. It is usually at once arrested by suture of the dura mater, and it is quite unusual to find any appreciable amount of discharge on the dressings. But if the dressings become soaked, they should be changed as often as necessary to keep clean and dry and the wound painted with iodine.

Injury to the contents of the vertebral canal must, of course, be most carefully guarded against, and extreme care and gentleness are necessary in removing the laminæ and in handling the cord. In the normal spine there is a considerable interval between the arches and the theca, this space being occupied only by a little lax tissue with some fat, and it is here easy to introduce the ends of bone-forceps into the canal and to cut freely. In the case of intra-meningeal tumours there is also generally abundance of room, but the perimeningeal space is apt to be slightly lessened and its connective tissue is often increased in density and less obviously fatty. In tuberculous cases with no marked kyphosis there is also a wide space, and the tuberculous material which occupies the space serves to protect the theca during the manipulations for its exposure. Similar conditions will also be met with in the case of extra-meningeal tumours.

It is thus in the case of injury and of some tuberculous spines with marked kyphosis that the greatest difficulty is met with, as in these the lumen of the vertebral canal may be greatly restricted and the utmost care is required in removing the laminæ. The safest course is to make the first opening not through the most depressed lamina, but through the prominent one beneath it, so that the exact position can be more clearly seen and the available space estimated. In the subsequent section of the compressing lamina the saw is used with great care and carried only partially through the bone, after which the bone-forceps are applied vertically, no attempt being made to insinuate one point beneath the bony arch.

It is obviously very necessary not only to avoid injury in removing bone but to guard against pressing on the theca with swabs, and assistants must be warned and most carefully watched to prevent any rough use of sponges, to which they are the more prone as in the early stages of the operation firm pressure has been a necessity. It is also essential to use the utmost gentleness in raising the theca to attack its anterior aspect.

Interruption of the continuity of the spine is also a real danger in cases of severe injury and in advanced tuberculous disease or malignant growths of the bodies of the vertebræ. In such cases the bodies may be so completely destroyed that on removal of the laminæ there is no sufficiently firm tissue left to maintain the integrity of the column, and there is the greatest danger that the cord will be crushed in moving the patient, or that the back will not again be fit to carry the body weight. In traumatic cases and in malignant disease such a result would be of little importance, as life could not be prolonged under any circumstances, but in tuberculous disease it may aggravate the pre-existing trouble. It is therefore advisable, in cases of Pott's curvature with marked deformity, to ascertain by radiography whether the bodies of the vertebræ are still sufficiently well defined to be reasonably likely to maintain their continuity. If ankylosis of the laminæ is found, the operation should be discontinued, because after their removal one may find the spine absolutely flaccid and unable to bear the weight of the body.

Tuberculous infection of the wound or cicatrix is best avoided by the thorough removal of the disease at the time of operation, but will probably always constitute a serious difficulty in this as in other operations for tuberculous bone disease. The danger is probably increased by drainage, which should therefore be avoided whenever possible, but if evacuation of an abscess cavity can be effected by some route other than the spinal canal such a 'safety-valve' should certainly be provided. The danger of tuberculous invasion of the scar may also be diminished by the use of a slight flap in cutting the superficial structures, and this has the advantage of leaving intact the frequently damaged skin over the angle of curvature. The flap is taken in a gentle curve round the prominent angle, leaving and returning to the middle line; it goes through superficial structures only, and after it has been reflected the muscles are divided by the usual vertical incisions.

Weakening of the back so that it is permanently unable to support the weight of the head or body has been occasionally met with, but is probably best avoided by keeping all muscular incisions absolutely longitudinal and by closely suturing the muscles together at the end of the operation. If this be done a very firm scar is secured, and the writer has never seen any inconvenience result from weakness, while many patients are able afterwards to carry on laborious work without any inconvenience. In tuberculous cases it is, of course, necessary to treat the bone disease after operation, and, as in all other cases of spinal caries, the results may be unsatisfactory; in traumatic cases it is also advisable to support the spine for about two months after the injury; but in the case of tumours and of operation upon old traumatic cases no support is required, and the back is quite strong enough for the patient to sit and stand up after three or four weeks, which is probably the shortest time at which his paraplegia would permit him to do so. Speaking broadly, the results as regards the strength of the spine are so satisfactory that it is rarely if ever necessary to adopt any osteoplastic operation or to secure the laminæ by wire sutures.

SECTION VI

OPERATIONS UPON THE GENITO-URINARY ORGANS

PART I

OPERATIONS UPON THE KIDNEYS AND URETERS

BY

DAVID NEWMAN, M.D. (Glasg.)
Surgeon to the Glasgow Royal Infirmary

WITH A PRELIMINARY CHAPTER UPON

CYSTOSCOPY

BY

J. W. THOMSON WALKER, M.B., C.M. (Edin.), F.R.C.S. (Eng.)
Assistant Surgeon, St. Peter's Hospital for Stone; Surgeon,
Hampstead General Hospital

CHAPTER I

CYSTOSCOPY

By J. W. THOMSON WALKER, M.B., C.M. (Edin.), F.R.C.S. (Eng.)

METHODS OF CYSTOSCOPY

THERE are two methods of cystoscopy, the direct and the indirect:

Direct Cystoscopy. This method has been especially advocated by Kelly, and has been modified by Luys, Braasch, and others.

Kelly's specula are plated metal cylinders 3½ inches long, and of the same diameter throughout. There is a funnel-shaped expansion at the outer end of the speculum, and a handle 3 inches long is attached to the funnel. The specula are made in various sizes from 5 to 20, each number representing the diameter in millimetres. Each instrument has an obturator which is used during introduction. A dilator is used to enlarge the orifice of the urethra and an evacuator to remove the urine, which accumulates in the bladder during a prolonged examination. The evacuator consists of a rubber exhausting bulb and 14 inches of fine rubber tubing, and at the bladder end a small hollow perforated metal ball.

The lower bowel is emptied, and immediately before examination the bladder is emptied in the sitting or standing position. General anæsthesia is necessary in nervous individuals. Local anæsthesia is obtained by cocaine (1%) introduced on pledgets of wool.

Two positions are used: (*a*) the elevated dorsal and (*b*) the knee-chest.

(*a*) The dorsal position is less trying to the patient, but is only of service in thin patients, and the atmospheric expansion of the bladder is not so good. The bladder of stout patients will rarely distend at all in this position. The buttocks are raised 8 or 12 inches above the table level, the speculum is introduced, the obturator withdrawn, and atmospheric pressure distends the bladder.

(*b*) In the knee-chest position, the patient kneels with the knees slightly separated close to the end of the table, and allows the back to curve well in with the buttocks fully raised. If an anæsthetic is required the patient may be held by assistants or a sling apparatus.

The speculum is introduced, the obturator withdrawn, and light projected into it from a forehead mirror. After an examination the bladder is emptied by introducing a catheter and gently lowering the patient to the horizontal. Kelly's method is only applicable in the female subject, and the position is an exhausting and embarrassing one.

Luys has modified this method, and uses it in the male also. His instrument consists of a metal tube of 10 cm. for the female and 18 cm. for the male. On the floor of the tube is a fine tunnel leading to a small tube to which a rubber tube is attached. This leads to a vacuum bottle, and prevents the accumulation of urine in the bladder. The plunger that closes the tube during introduction is straight in the instrument for the female, and angled in that for the male. The patient is placed in the Trendelenburg position with local or general anæsthesia.

As a method of examination direct cystoscopy is inferior to indirect. With the tube only a small area of bladder wall is seen, and the instrument must approach it closely in order to get a good view. An area at the apex and the anterior wall are inaccessible to examination. With the prismatic cystoscope, on the other hand, an extensive field is displayed, and a broad bird's-eye view can be obtained. The advantage of the direct, or open method, is the facility it affords for topical application in cystitis, for operations on small papillomata, and for the removal of foreign bodies from the bladder.

Indirect Cystoscopy. The indirect method is that most commonly in use. The simplest form of cystoscope consists of a telescope and lighting apparatus combined. Before using this instrument, it is necessary to pass a catheter and distend the bladder with fluid. The cystoscope is then introduced, and when the inspection is finished it is removed, and the catheter again passed to empty the bladder.

The irrigation cystoscope consists of an outer tube which acts as a catheter, and carries the lighting apparatus, a small metal filament lamp, set at an angle to the shaft of the tube. At the proximal end of the tube is a valve which prevents the fluid escaping.

In the Ringleb pattern of cystoscope, the valve is a trapdoor kept shut by springs in a compartment at the end of the tube. This has the disadvantage of collecting pus and débris, and requires very careful cleaning. In the author's pattern of irrigating cystoscope (see Fig. 257), the outer catheter tube can be boiled, and the valve which closes the distal end acts by a spring placed outside the lumen, so that there is no dead space for the collection of septic material. The valve may also be used as a turncock. The telescope is separate, and is a long tube containing a number of lenses and a prism at the distal end; it is made by Zeiss, and gives a very sharp magnified erect image.

The advantage of the irrigating cystoscope is that only one introduction of the instrument is required, and should it be necessary to wash the bladder during the cystoscopy, this can be done by withdrawing the telescope without removing the outer tube from the urethra.

The cystoscope can be cleaned with ether soap and carbolic lotion (1 in 20) or biniodide of mercury solution (1 in 1,000), and care should be taken to flush the catheter tube with the antiseptic. If the author's pattern is used, the catheter tube may be boiled for two or three minutes, taking care that the lamp is well screwed on to prevent water getting between the lamp and the metal contact, which causes short-circuiting of the electric current. The telescope is cleaned with ether soap and antiseptic. It is not boiled.

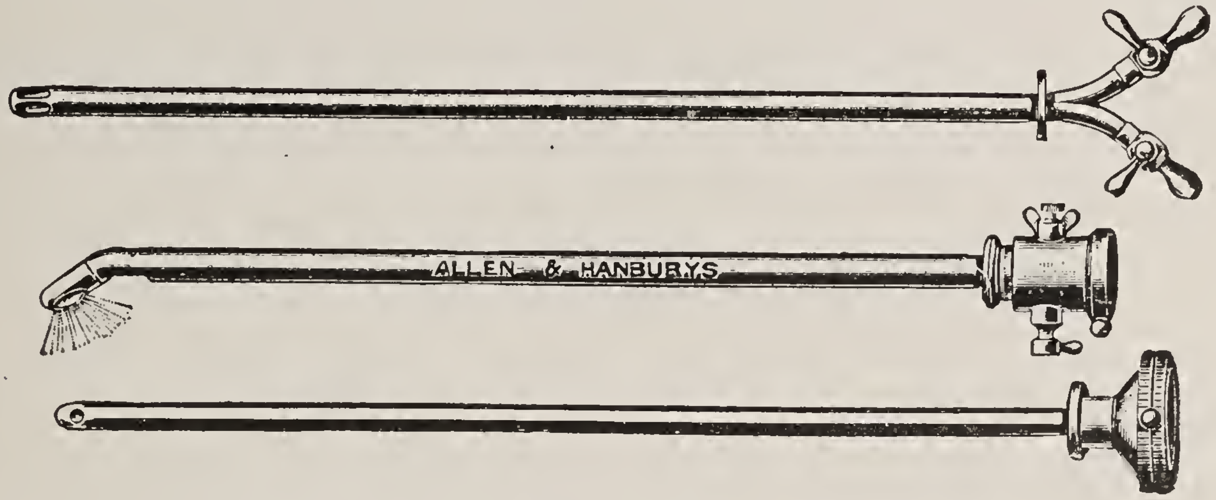


Fig. 257. Irrigating Cystoscope with the Author's Valve.

The electric current may be derived from an accumulator, dry cell, or from the main electric supply. For metal filament lamps small dry cells (4½ volts) can be obtained; they are small, light, and inexpensive. For carbon filament lamps a higher voltage is required, and large accumulators or batteries are required. In taking the current from the main a rheostat is required, and an additional small, finely graduated rheostat can be affixed to the contact of the rheostat.

METHOD OF PERFORMING INDIRECT CYSTOSCOPY

There are three essentials for a successful cystoscopy, namely, (1) a patent anæsthetic urethra, (2) a bladder capable of distension, and (3) a clear distending medium.

(1) **The Urethra.** The calibre of the irrigating cystoscope is 21 or 22 F, and the urethra must be capable of taking this size of instrument. In the male the meatus may be too small to admit the cystoscope. Graduated metal instruments for dilatation of the meatus can be obtained, but the ordinary metal urethral instruments may be used. If these fail to dilate the meatus sufficiently, a meatotomy is performed by slitting the meatus downwards. A stricture of the urethra must be

dilated or cut by internal urethrotomy if necessary. An enlarged prostate may give rise to difficulty in passing the cystoscope on account of the distortion of the prostatic urethra it produces, or from its size.

General anæsthesia is rarely required. It may be necessary where the bladder or urethra is intensely sensitive or the patient highly nervous or in young unmarried women. Local anæsthesia of the urethra should be produced in the male subject, but is unnecessary in the short female urethra; it is produced by instilling 15 or 20 minims of a 4% novocaine or 1% cocaine solution or by combination of alypin and suprarenin (tablets of alypin, grain 1/3, to 2 minims of 1 in 1,000 suprarenin borate solution). The fluid is introduced into the prostatic urethra by means of a Guyon catheter and syringe, or is placed in the anterior urethra with a glass pipette and rubber teat and massaged back into the prostatic portion. Anæsthesia of the bladder and posterior part of the urethra may also be obtained by injection into the rectum of antipyrin (grains 25) and opium (tinct. opii, minims 15) in 5 oz. of warm water, half an hour before the examination.

(2) **Distension of the Bladder.** The normal bladder holds from 10 to 12 oz. comfortably, and this quantity should be aimed at in distending the bladder for cystoscopy. Air and oxygen gas have been suggested as media for distension of the bladder. They have many disadvantages when compared with a fluid medium and are rarely used. Very rarely a case is seen where the bladder is filled with friable papillomatous growths, bleeding at the slightest touch, and rendering cystoscopy in a fluid medium extremely difficult. In such a case distension of the bladder with air may give a somewhat better view.

Boric acid solution with an equal quantity of warm sterile water or sterilized water alone is used for washing and filling the bladder. The fluid should be a little above the body temperature and must be introduced slowly.

A bladder syringe or an irrigator may be used. I prefer a bladder syringe, as by it the quantity introduced into the bladder and the intravesical pressure can be accurately gauged. The best syringes have a glass barrel and a metal or asbestos plunger, and have a capacity of 4 or 8 oz. When an irrigator is used the glass nozzle at the end of the rubber tubing is inserted into the catheter portion of the cystoscope and the fluid slowly run in from a head of 2 or 3 feet, the quantity being carefully watched and controlled by grasping the rubber tube. This is especially necessary when the patient is under general anæsthesia.

Bladder spasm may be produced by too rapid and forcible injection of the fluid, or by the fluid being too cold, and these causes should be avoided. In an inflamed bladder the capacity is temporarily diminished and the introduction of fluid may give rise to spasm, so that only 2 or 3 oz. are retained. By care and gentleness it may be possible to get the bladder to hold more fluid, but no attempt must be made by forcing the fluid in to overcome the muscular contraction.

Rectal anæsthesia, as given above, frequently assists in these cases, and occasionally the bladder may be soothed by washing it with a solution of antipyrin (1 in 20). A general anæsthetic is of advantage when the bladder is very sensitive, but the bladder reflex is not abolished by general anæsthesia, and when the bladder is filled to its full capacity (possibly only 2 or 3 oz.) the breathing becomes hurried and deeper, and if the distension is forced, the fluid is ejected from the bladder. Where the bladder is acutely inflamed it is wise to defer the examination until the cystitis has subsided.

(3) **A clear medium.** Where the urine is clear it should be drawn off and the bladder distended with 10 oz. of warm boric solution. When blood is mixed with the urine washing may be necessary. The bladder is filled repeatedly with boric solution, and this is allowed to flow out. The fluid may quickly clear, and when the colour has completely gone from the washing, tested by examining it against the light in a clear glass, the bladder is filled and the cystoscopy commenced.

A urine the colour of burgundy may quickly clear. If it does not, and especially if after partly clearing the fluid again becomes stained, a weak solution of nitrate of silver (1 in 10,000 to 1 in 8,000) should be tried as a wash. In persistent hæmorrhage the doubleway catheter supplied with the irrigation cystoscope and inserted inside the catheter tube in place of the telescope should be used, and a continuous stream of lotion passed through the bladder, taking great care that the inlet tube admits rather less than the outlet tube is capable of discharging, and thus avoiding distension of the bladder. In continuous bleeding a drachm of adrenalin solution (1 in 1,000) may be injected through the catheter, and, after remaining in the bladder a minute, washed out. The most difficult form of bleeding to control is a slight oozing from a malignant growth or a tuberclous ulcer, and this is frequently produced by the attempt of the cystoscopist to distend the bladder beyond its diminished capacity.

In pyuria there may be difficulty in obtaining a clear medium, but usually it is only a matter of patience in washing the bladder. Occasionally large quantities of pus may be rapidly discharged into the bladder from a collection in the renal pelvis or churned up from a diverticulum, and so render cystoscopy difficult.

TECHNIQUE OF INDIRECT CYSTOSCOPY

The cystoscope is sterilized and placed in a tall jar containing carbolic lotion (1 in 40). The lighting apparatus is carefully tested. The patient either lies on a high couch with a sand-pillow beneath the pelvis, or sits in a special chair with the knees and hips flexed and the thighs widely apart—or he may be placed in the lithotomy position. The urethra is anæsthetized and sufficient time is given for the anæsthetic to take effect.

The catheter portion of the cystoscope is dipped in glycerine and passed gently along the urethra and fully depressed between the thighs as it rides over the prostate at the posterior lip of the internal meatus. The hollow plug which opens the valve of the catheter portion is inserted and the bladder emptied. If necessary the bladder is washed in the manner already described and the medium tested in a clear glass by holding it to the light. When the returning fluid is absolutely clear the bladder is carefully filled with 10 or 12 oz. of fluid. The hollow plug is now removed, the telescope inserted, and the electric terminal slipped into its groove. The light is now switched on and the cystoscopy commenced.

Cystoscopic appearances of the normal bladder. The interior of the bladder should be systematically examined. The window is first turned directly downwards, and the direction will be seen by observing the position of the small metal knob on the rim of the ocular end of the telescope. The trigone comes into view. The mucous membrane of this part is darker in colour and coarser in texture than the rest of the bladder. The blood-vessels are much more numerous and are larger, and they spread out fanwise from the urethra. The ureteric ridge or bar of Mercier will usually be seen as a transverse ridge, but it may only be marked by the difference in colour between the darker trigone and the lighter surrounding mucous membrane.

Following this ridge outwards, first on one side and then on the other, it will be found to rise and become more prominent and is then lost on the bladder wall. On the prominent part of the ridge is a small red slit, the ureteric orifice, and this will come into view when the window is turned one-eighth of a circle to one or other side.

From the ureteric orifice or from its immediate neighbourhood a comparatively large blood-vessel passes out and splits into two branches, or there are two vessels issuing from the ureter which pass outwards and backwards. These vessels may serve as a guide to the orifice where it is difficult to find. A method of finding the ureteric orifices which may be useful to the beginner is chromocystoscopy. This is very rarely

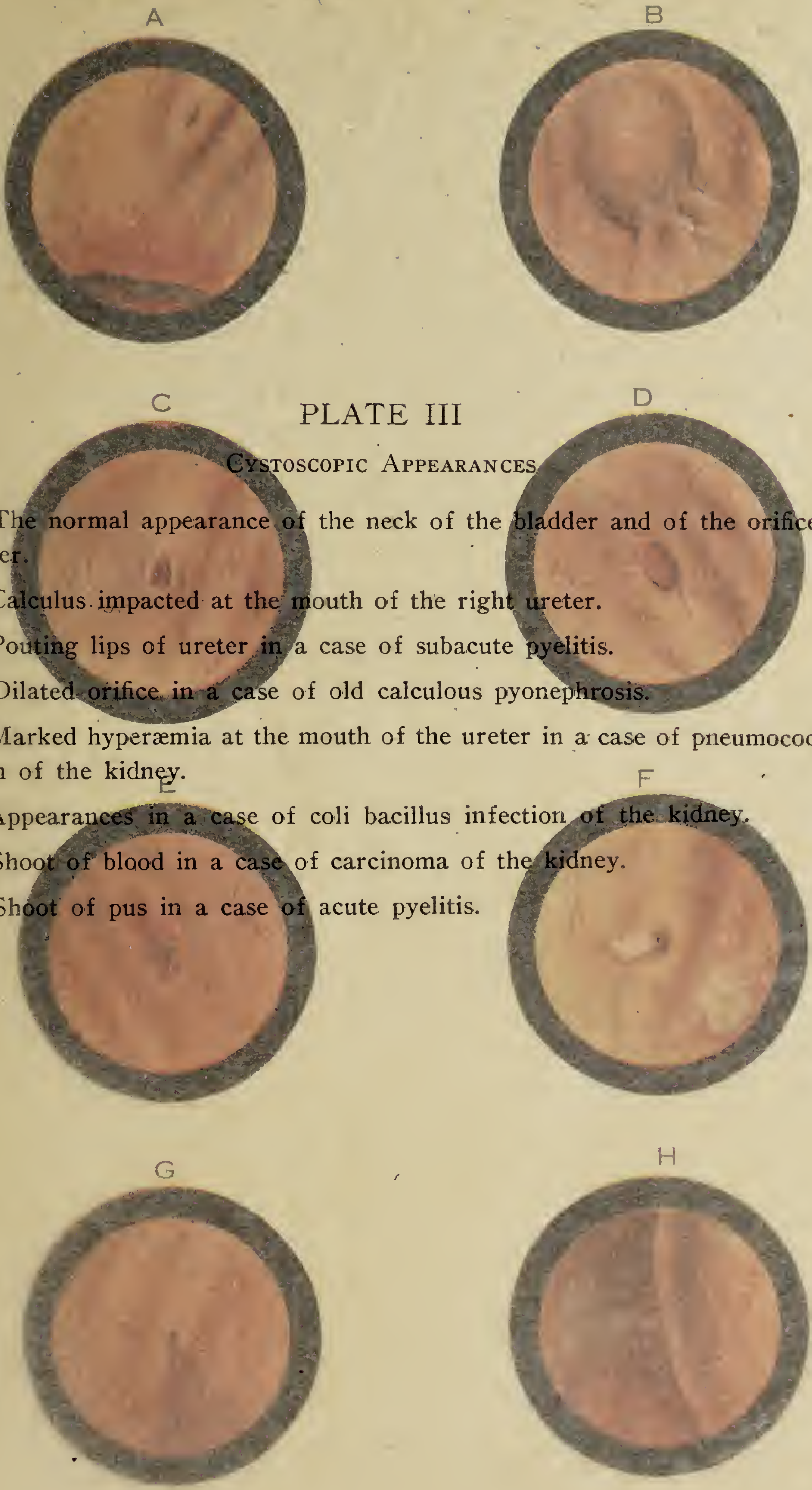


PLATE III

Cystoscopic Appearances

A. The normal appearance of the neck of the bladder and of the orifice of the ureter.

B. Calculus impacted at the mouth of the right ureter.

C. Pouting lips of ureter in a case of subacute pyelitis.

D. Dilated orifice in a case of old calculous pyonephrosis.

E. Marked hyperæmia at the mouth of the ureter in a case of pneumococcus infection of the kidney.

F. Appearances in a case of coli bacillus infection of the kidney.

G. Shoot of blood in a case of carcinoma of the kidney.

H. Shoot of pus in a case of acute pyelitis.

To face p. 528

TECHNIQUE OF INDIRECT CYSTOSCOPY

The cystoscope is sterilized and placed in a tall jar containing carbolic lotion (1 in 40). The lighting apparatus is carefully tested. The patient either lies on a high couch with a sand-pillow beneath the pelvis, or sits in a special chair with the knees and hips flexed and the thighs widely apart—or he may be placed in the lithotomy position. The urethra is anæsthetized and sufficient time is given for the anæsthetic to take effect.

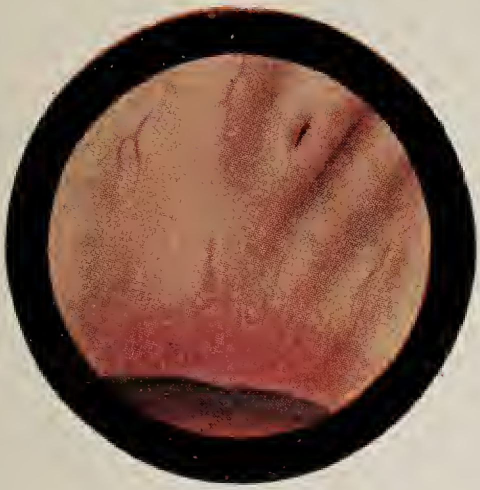
The catheter portion of the cystoscope is dipped in glycerine and passed gently along the urethra and fully depressed between the thighs as it rides over the prostate at the posterior lip of the internal meatus. The hollow plug which opens the valve of the [illegible] is inserted and the bladder emptied. If necessary the bladder is washed in the manner already described until the [illegible] holding it to the light. When the returning fluid is absolutely clear the bladder is carefully filled with [illegible] now removed, the telescope inserted [illegible] into its groove. The light is now switched on and the [illegible] menced.

Cystoscopic appearances [illegible] of the bladder should be systematically [illegible] turned directly downwards [illegible] the position of the small metal knob [illegible] the telescope. The [illegible]

[illegible]

[illegible] very rarely

A



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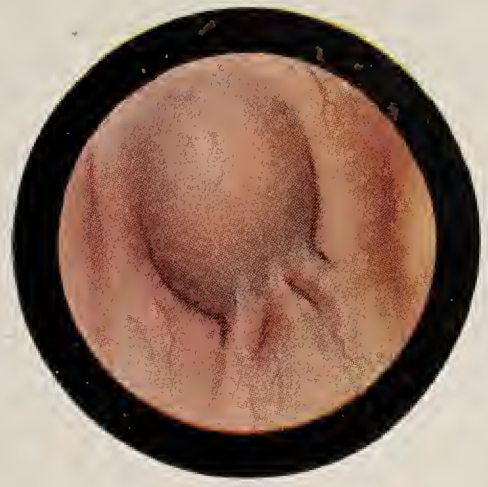

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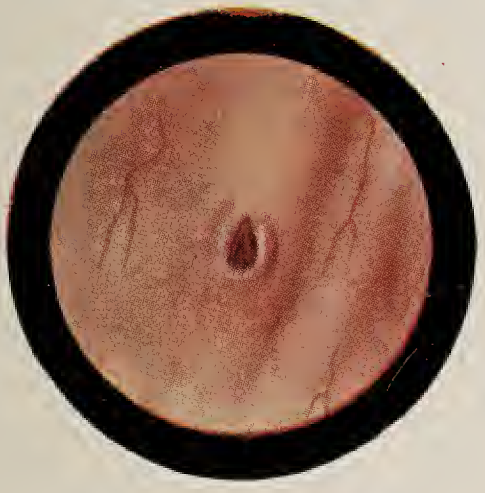

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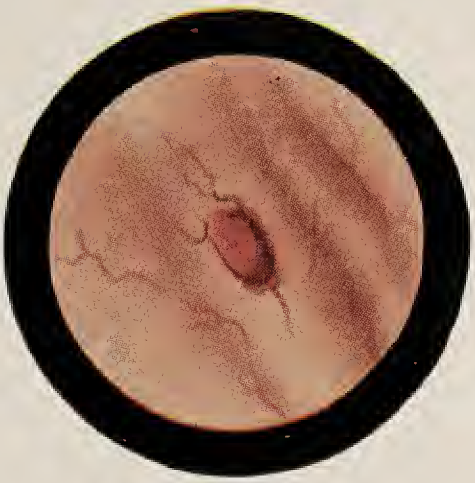

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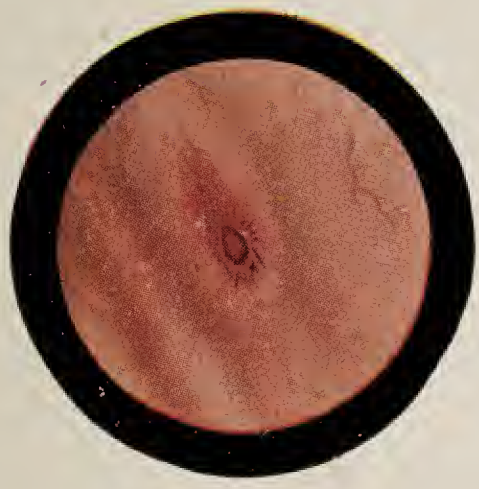

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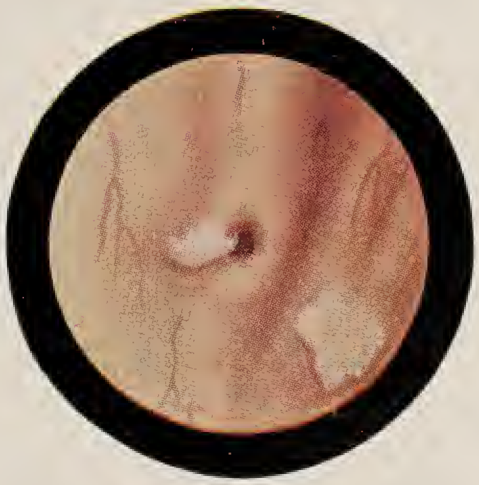

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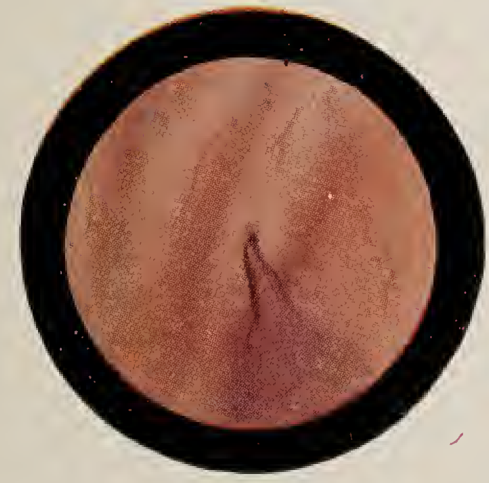

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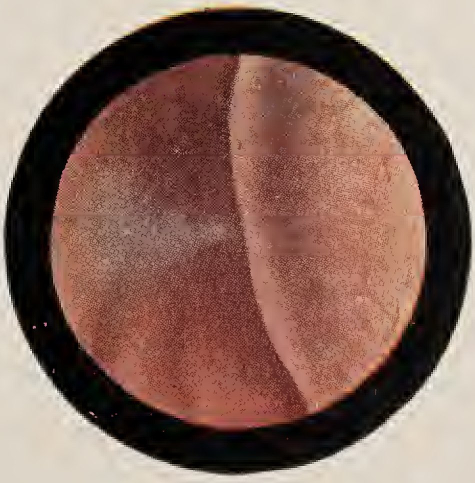

required by an experienced cystoscopist, and only where advanced disease of the bladder has caused distortion of the bladder base and obliterated the natural features of the trigone. Thirty minims of a solution (4%) of indigo carmine are injected into the muscles of the thigh, and in about twenty minutes the urine issuing from the ureteric orifice is deeply coloured with the blue dye and has the appearance of puffs of dark smoke tailing off in a blue streak.

The normal ureter takes a great variety of appearances which can only be learned by constant practice in cystoscopy. On watching the ureter, the ridge to its outer side is seen to thicken and then the part of the ridge on each side of the ureter becomes drawn up and rigid. The ureteric orifice gapes and emits a jet of fluid. In the normal state this is clear and is only seen as a swirl of fluid at the orifice and across the trigone. The number of ureteric contractions varies—usually a contraction occurs once in about 8 or 10 seconds, but under the influence of the light, or for other reasons, it may occur only at intervals of 1 or 2 minutes or even longer in quite healthy individuals. Where there is polyuria or some cause for irritation in the ureter the contraction may be rapidly repeated with increased vigour.

The posterior or postero-superior wall, the lateral walls, and the anterior wall are now examined in turn. The mucous membrane has a yellowish sandy colour, and in the normal state is light-reflecting. In the fully distended bladder a slight ridging may be observed from the prominence of muscular bands, but this is never prominent in the normal bladder. In a partly distended bladder the mucous membrane is thrown into folds and appears darker in colour—occasionally a peculiar honeycomb appearance is presented by the mucosa of the partly distended bladder. The blood-vessels are few in number and appear at irregular intervals through the mucous membrane and split up into fine twigs. Larger vessels in the deeper layer of the mucous membrane are frequently seen as ill-defined blue tracts. At the highest part of the bladder an air-bubble, introduced by the catheter, is invariably seen. It serves to mark the apex of the bladder.

In order to see the upper part of the bladder clearly the instrument is pushed in and the eyepiece depressed. The parts of the bladder which are most difficult to examine are the upper part of the posterior wall and the anterior wall, the latter appearing perspective as it rises almost vertically from the urethral orifice. Pulsation may be observed in the lateral walls or base, and is especially evident where a tumour is present in the interior of the bladder. It is due to the close proximity of the internal iliac artery. Vermicular waves may be seen sweeping across the postero-superior wall, and are due to peristaltic movements of small intestine in the rectovesical pouch in the male or above the uterus in the female.

CYSTOSCOPY IN ITS RELATION TO OPERATIVE SURGERY

Foreign bodies and calculi in the bladder are readily seen by means of the cystoscope. A very large calculus, although it may be felt grating on the point of the cystoscope, may be difficult to view on account of its close proximity to the window, or because the point of the cystoscope gets wedged between the calculus and the wall of the bladder with the window looking towards the bladder wall. Calculi lying behind a prostate which are inaccessible to the bladder sound are readily seen by the cystoscope. A calculus lying in a sacculus and one projecting from the orifice of the ureter can be seen. A diverticulum with a small round orifice may, however, conceal a large calculus without any sign being observed on cystoscopy. The diagnosis of vesical calculus by means of the cystoscope is more accurate than by any other method. An X-ray shadow in the bladder area may be thrown by a calculus in the lower end of the ureter, in the bladder, or in a diverticulum, and between these cystoscopy will readily discriminate.

The choice of operation in calculus of the bladder is assisted by cystoscopy. In expert hands litholapaxy is the operation of choice. Where an intravesical projection of the prostate is found with the cystoscope, even where the prostate is only moderately enlarged when felt from the rectum, litholapaxy will be replaced by prostatectomy with removal of the calculus through the suprapubic wound. Where a large congenital sacculus or a sacculated bladder is discovered by the cystoscope, suprapubic lithotomy should replace litholapaxy. Examination of the bladder by the cystoscope after litholapaxy ensures that no fragments are left behind.

Papilloma or villous tumour of the bladder forms a striking cystoscopic picture. The tumours most frequently resemble a well-formed bath sponge, but when the villi of which they are composed are long they have the appearance of a mass of seaweed. On close inspection the villi are flat and resemble closely massed leaves, or they have rounded knob-like ends. Fine vessels can be traced in the villi. Papillomata may be pedunculated or have a very short narrow base, or they may be sessile. The presence of a long pedicle can only be ascertained by noting marked changes in the position of the growth on subsequent examinations. A thick fleshy pedicle is sometimes observed and is compatible with a simple type of papilloma. In all cases of multiple papilloma a carefully constructed chart of the tumours should be drawn before operation, so that no single tumour is overlooked at the operation.

Malignant growths are found in a number of different forms. Examination of the growth with the cystoscope will give an idea of its position and extent, and show whether it is suitable for operative treatment. In gauging the extent of the growth by cystoscopy it should be remembered that only the intra-vesical and surface spread can be estimated. The intramural growth in the muscular layer is usually more extensive than appears on the mucous surface, and can only be accurately estimated by the finger after suprapubic cystotomy. The extra-vesical spread, if the growth has passed through the bladder wall, cannot be gauged by the cystoscope and is only revealed by an operation.

CYSTOSCOPY IN DISEASES OF THE KIDNEY

Examination of the ureteric orifices. Inspection of the orifices of the ureters is made with the object, firstly, of localizing disease to one kidney and if possible making a diagnosis of the nature of the disease, and, secondly, of judging as to the health of the second kidney when nephrectomy is proposed.

There is no efflux and no contraction of the ureteral orifice when the kidney is congenitally absent or has been removed, or when there is a ureteric fistula and the ureter has been completely severed, or when there is complete obstruction of the ureter. When there is a ureteric fistula and the duct is not completely cut across, contractions but no efflux are observed at the ureteric orifice. In complete blockage of the ureter high up, as in closed hydronephrosis, a feeble contraction may be observed at the ureteric orifice at long intervals. The efflux is more copious where polyuria is in progress, and in such cases the increased volume can be distinguished at the ureteric orifice. Ureteric contractions occur also with greater frequency. Such polyuria may result from diuretics or it is observed in such surgical diseases as early tuberculosis, advanced interstitial nephritis from long-continued obstruction (stricture, enlarged prostate). and occasionally in calculus. The presence of an irritant such as a calculus in the ureter or of acute or subacute inflammation of the renal pelvis or ureter (as in bacillus coli or other infections) causes an increased frequency of contraction of the ureter, and each contraction is more vigorous. In some cases of acute ureteritis each contraction seen at the ureteric orifice amounts to a spasm.

A trace of pus in the urine, sufficient to produce slightly cloudy urine in a test tube, cannot be distinguished at the ureteric orifice unless there are solid flakes in the urine. A decidedly cloudy urine containing pus and débris momentarily clouds the cystoscopic view as it shoots from the ureter, and then the medium clears again as the cloud diffuses. A urine which shows a distinct murky jet at the ureteric meatus will appear much more opaque when collected in a glass jar. In advanced suppuration of the kidney, where only a small quantity of urine is secreted, a worm of semi-solid waxy-looking pus is seen to issue from the ureter, roll down the side of the ureteric ridge and break off, to be succeeded after an interval by another pipe of pus.

Blood in the urine can be detected at the ureteric orifice when the urine is tinged with colour, and is very evident when severe renal hæmaturia is in progress. In severe hæmorrhage a clot may be observed projecting from the ureter as a dark brownish-black irregular mass, which may project and recede at each ureteric contraction, and allow a trickle of bright red blood to pass alongside.

The absence of the ureteric orifice indicates that the kidney is absent on that side. A ureteric orifice and a ureter patent for several inches may, however, be present when the corresponding kidney is absent or completely atrophic. A double ureteric orifice indicates the presence of a double ureter. The orifices are usually situated close alongside each other in a broad ureteric ridge.

In infections of the kidney and pelvis the ureteric orifice shows evidence of the inflammation. This varies very greatly according to the severity and duration of the infection. In slight cases there may be only a little thickening and elongation of the lips; in more severe pyelitis there is a halo of cystitis around the ureteric orifice, and the lips are thickened and puffy in appearance. In some cases the area around the ureteric orifice is bright scarlet and the ureteric ridge is raised, thick, and thrown into innumerable folds and ridges of bright red mucous membrane, while the orifice is buried among the folds. In old-standing inflammation affecting the ureter, the orifice is open, round, and rigid, and contractions are absent or fail to close it completely.

In tuberculosis of the kidney a great variety of appearances may be observed. There may be slight thickening and elongation of the lips, deposit of yellow tubercles on the lips or around the orifice, and ulceration of the lips which later spreads round the orifice and conceals it. Œdema around the orifice forming a ring, or mass of vesicles in which the orifice is buried, is sometimes present. In the later stage of chronic tuberculosis of the kidney and ureter the orifice is displaced outwards and backwards, and appears as a tunnel-like opening into which the muscular ridge of this branch of the trigone is seen to disappear. The ureter in such cases is thick, hard, and contracted. In stone in the ureter the appearances may be those of infection already described.

After an attack of renal colic, a splash of hæmorrhage may be observed at the orifice. Large masses of œdematous mucous membrane may surround the orifice in some cases of ureteric calculus. A calculus may project from the orifice as a white or brown mass, or when the surface is crystalline it scintillates in the electric light.

Catheterization of the ureter. This method has completely superseded intra-vesical separation of the urines.

A special catheterizing cystoscope is required. This is similar to the irrigating cystoscope with the addition of a tunnel along the upper surface of the shaft (see Fig. 258). The tunnel opens at the ocular end in a tube provided with a small hole through which the catheter passes, and there is a stopcock to prevent the escape of fluid when the catheter is not in position. At the distal end of the cystoscope the tunnel opens just short of the prism window, and there is a small elevator raised by a screw at the ocular end. A double or a single tunnel may be provided. The double tunnel makes a larger instrument which is more difficult to pass. The patient is prepared as for cystoscopy, the catheterizing cystoscope is introduced, and the telescope placed in position. The ureteric catheter, carefully rendered aseptic, is placed on a sterilized towel, lubricated with glycerine, and passed along the tunnel of the

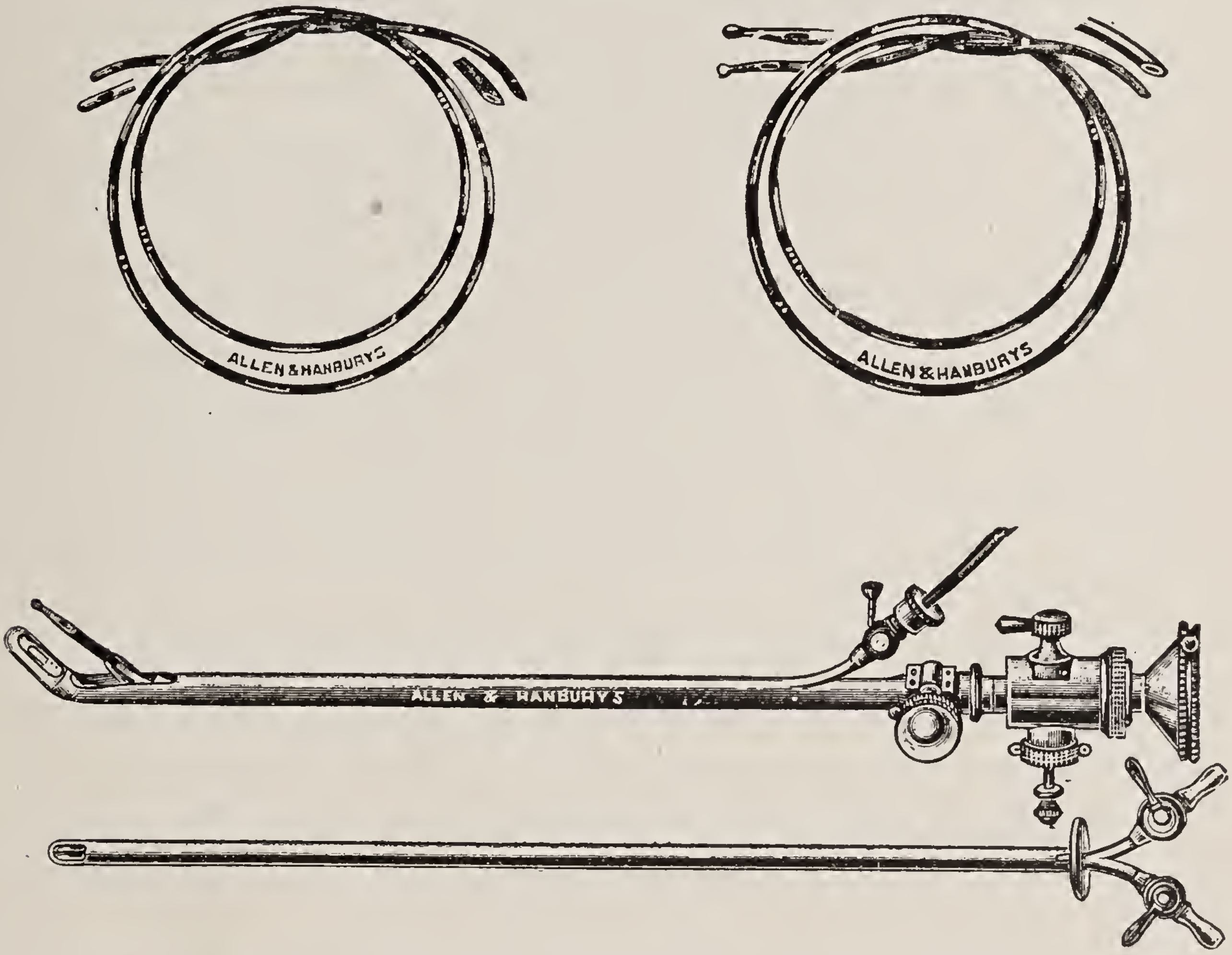

Fig. 258. Catheterizing Cystoscope and Ureteral Bougies. The ureteral catheters may either have a blunt end or they may be probe-pointed; they are graduated and marked by alternate dark and light segments.

cystoscope. The telescope must be in place when the catheter is passed through the cystoscope, as it forms the floor of the catheter tunnel.

The window of the cystoscope is now turned downwards and the inter-ureteric bar comes into view; following this outwards by turning the cystoscope in its axis, the opening of the ureter comes into view. The ocular end of the cystoscope is now raised and drawn towards the side opposite to the ureter which is to be catheterized. By this manœuvre the window of the instrument approaches close to the ureteric orifice. The point of the catheter is now pushed in until it is well in view of the window. Its axis is still, however, too near that of the shaft of the cystoscope to permit of it engaging in the ureteric orifice. A touch of the screw at the base of the cystoscope raises the little elevator at the distal end of the tunnel, and the point of the catheter rises away from the cystoscope and is easily slipped into the ureteric orifice. Care should be taken not to raise the elevator too far, as the catheter does not run so easily when it is erect. The use of the elevator is reserved for the final stage, the preliminary manœuvring being done with the whole cystoscope.

When the point of the catheter has entered the ureteric orifice it is seen raising up the mucous membrane of the intramural portion of the ureter. The cystoscope is held firmly in position and the catheter pushed gently on. When the point is fairly in the ureter, the elevating screw should be lowered and the catheter runs more easily. My catheters are marked in different colours each ½ inch, and there is a single red ring at 6 inches, a double red ring at 12 inches, and three red rings at 18 inches. It is thus possible to tell exactly in what part of the ureter the point of the catheter lies, and where it meets an obstruction. The point lies a little above the line of the pelvis when the 6-inch mark disappears and has entered the pelvis when the 12-inch mark passes into the ureteric orifice.

If it is intended to catheterize both ureters a double catheterizing cystoscope may be used, or the single catheter cystoscope may be withdrawn leaving the catheter in position, re-loaded, and re-introduced. I use a single barrel catheter cystoscope, as it is seldom necessary to catheterize both ureters simultaneously, and the single barrel instrument is of smaller calibre, and therefore more easily introduced in the male.

The difficulties of catheterizing the ureters are, firstly, those of cystoscopy, and none but a skilled cystoscopist should attempt this delicate procedure. An enlarged prostate may render catheterization of the ureters impracticable, and a tuberculous prostate may cause difficulty by interfering with the freedom of movement of the cystoscope. When cystitis is present the bladder may not tolerate sufficient distension, but to those practised in the operation two or three ounces capacity will suffice. There may be difficulty in reaching a ureter which opens in the back of a ridge or of finding the opening in an ulcerated area. The ureteric orifice may be too rigid or it may be naturally too small to admit even a fine-pointed catheter. The catheter may be arrested an inch or 1½ inches from the orifice in a healthy ureter; this may be due to contraction of the levator ani muscle, or to an over-distended bladder.

Examination of the urines of the two kidneys obtained by catheterization of the ureters.[1] This has two chief applications:—

(*a*) Where disease of the kidney is known to be present and there are no symptoms pointing to one kidney, and inspection of the ureteric orifices does not give definite information. Examination of the urine of each kidney microscopically, chemically, and bacteriologically will give the desired information.

(*b*) Where nephrectomy is proposed, examination of the unblended urine of the second kidney gives information in regard to the presence of a second kidney, the presence or absence of disease in the kidney, and the functional power of the organ.

The procedure is as follows:—

A general anæsthetic is unnecessary, unless the patient is nervous or the bladder intensely sensitive. Half an hour before the examination a large draught of Contrexéville water is given.

The bladder is very carefully washed and catheterization of the ureter of the apparently healthy kidney is performed. The catheter is passed into the renal pelvis, a blunt-nosed catheter being used if it will pass. The cystoscope is withdrawn, leaving the catheter in position. A urethral catheter is passed and the bladder emptied and this catheter tied in. The ureteric catheter is fixed to the thigh of the side to which it belongs by means of a strip of adhesive plaster. Between the thighs a sterilized bottle labelled ‘ right ’ and another labelled ‘ left ’ are placed, the neck of each being covered with several layers of sterilized gauze, and through this the catheters are drawn. The knees may be held together by pinning a broadly folded towed round them. The patient is made as comfortable as possible.

One of the following tests for the renal function is now used.

(1) **Phloridzin test.** A subcutaneous injection of 5 milligrammes of phloridzin is given. Sugar is detected in the urine in a normal kidney in from fifteen to twenty minutes, and continues for two to two and a half hours. An injection of 5 milligrammes of phloridzin will normally produce from 1 to 2 grammes of glucose.

[1] Thomson Walker, *The Renal Function in Urinary Surgery,* 1908.

In healthy individuals the elimination of glucose by the two kidneys is equal and parallel. Where disease of the kidney is present the appearance of glucose is delayed and the amount produced by this organ diminished. Glucose is completely absent if there is advanced disease of the kidney. For this test the catheter is retained for two or two and a half hours, the urine is tested for sugar several times in the first three-quarters of an hour to ascertain when the elimination commences, and at the end of two hours to see if the elimination has ceased. The total quantity of glucose in the urine is estimated. The functional power of the kidney is judged by the presence or absence of delay in commencement of elimination and the total quantity of sugar eliminated.

(2) **The phenol-sulphone-phthalein test.** This consists in injecting a solution of phenol sulphone phthalein hypodermatically and observing the time of appearance and the percentage eliminated during the first three hours.

A diuretic is given half an hour before commencing the test. One cubic centimetre of phenol sulphone phthalein solution (6 mgr.) is injected hypodermatically. A few drops of sodium hydrate solution (25%) are placed in two test tubes and the urine from the catheters allowed to drop into these. When the drug commences to pass a definite pink colour appears, and as the quantity increases this darkens to a well-marked magenta.

The quantity of the drug eliminated is estimated by the use of a colorimeter.

In normal cases the colouring material is said to appear in from five to ten minutes; 40 to 60% of the drug is excreted in the first hour, 20 to 25% in the second, and 60 to 85% in the first two hours.

(3) **The indigo-carmine test.** A tablet containing 0.16 gramme of indigo carmine is dissolved in water and injected hypodermatically. The urine becomes tinged in ten or twelve minutes, and rapidly becomes green and then blue, the highest point of excretion being reached half or three-quarters of an hour after injection. Excretion continues in small quantities for about twelve hours. About 25% of the drug is excreted by the kidneys. The quantity is usually roughly estimated by the eye, but the percentage may be obtained by means of a colorimeter. Delay in the appearance and a feeble staining of the urine are signs of disease.

Examination of the urine of the second kidney. The urine is collected for two or two and a half hours and sufficient quantity is usually obtained during this time. Should the flow from the catheter cease, the lumen may be gently syringed with a little warm boric lotion, injecting about half a drachm with a ureteric catheter syringe. A cup of hot tea or other diuretic may also be given. If there is pain from the presence of the catheter it will be relieved by a hot fomentation applied to the abdomen. When sufficient urine has been collected, the catheters are withdrawn, and the patient given a dose of urotropin and a tumbler of hot Contrexéville water. The patient should remain in bed for twenty-four or thirty-six hours after the examination.

The quantity, specific gravity, are noted and a quantitative estimation of the urea made, and a microscopical examination of the centrifugalized deposit. The total quantity of sugar is estimated if the phloridzin test is used, and the percentage of phenol sulphone phthalein or of indigo carmine, if these tests have been employed.

Finally a bacteriological test is made, and the urine is examined for tubercle bacilli, guinea-pigs being injected if necessary.

Sounding the ureters. In obstruction of the ureter it is possible to ascertain the exact position of the obstruction. Where a stone is impacted in the ureter the catheter will be felt to hesitate and may either pass on or be arrested. On withdrawing the catheter when it has passed the calculus it may be felt to drag or even grate; the X-rays have, however, simplified the diagnosis. The passage of bougies opaque to the X-rays is an important adjunct to the radiography of ureteric calculus. Where a doubtful radiographic shadow lies in, or near, the line of the ureter, an opaque bougie is passed up the ureter and another plate obtained. The bougie may be arrested at the calculus, or it may pass alongside it, and the relation of the bougie and shadow will be seen. In difficult cases stereoscopic views should be taken.

PYELOGRAPHY

This consists in the introduction into the renal pelvis of a fluid opaque to the X-rays and obtaining a radiogram. By this means the size and outline of the renal pelvis and calyces are demonstrated.

The method is of use in detecting hydronephrosis in the early stage before the kidney has been destroyed, and thus enabling the surgeon to perform a curative operation. It is also invaluable in showing the relation of the kidney to obscure abdominal tumours and to radiographic shadows supposed to be urinary calculi. It has also been applied to other diseases of the kidney, but the practical use in these is less striking.

Collargol is the best drug for the purpose. It is used in a 10% or even a 20% solution, which is heated to a little above the body temperature. The barrel of a glass syringe of 40 c.c. capacity is used and the needle fits into the ureteric catheter. A ureteric catheter opaque to the X-rays is used. No general anæsthetic is used and no morphine should be administered before the operation.

The ureteric catheter is passed up to the pelvis of the kidney in the manner already described, and the contents allowed to run off. The barrel of the syringe is filled with warm collargol solution and the needle is inserted into the end of the catheter and raised to the full extent which the free end of the catheter permits (usually about 6 inches). The collargol solution slowly settles down in the syringe and fills the renal pelvis. At the first sign of discomfort in the kidney the instillation is stopped, the catheter plugged, and a radiogram taken. The plug is then removed and the collargol solution allowed to run off, the pelvis being washed with boric lotion. By this method very beautiful pictures of the renal pelvis and calyces are obtained.

Early hydronephrosis is indicated by clubbing of the calyces and by reduction of the angle between the lowest calyx and the upper end of the ureter. The position of the obstruction can also be shown, and the author has been able by this method to make an accurate diagnosis of an aberrant renal vessel causing hydronephrosis, when the kidney could not be felt on palpation.[1]

The use of this method is attended with some degree of risk in unskilful and unpractised hands. Rupture of the renal pelvis and injection of the tubules of the kidney have been recorded when the fluid was injected under considerable force. The utmost gentleness and delicacy of manipulation is imperative and no anæsthetic should be administered.

Lavage of the renal pelvis. In a few cases of intractable pyelitis lavage of the renal pelvis has been followed by cure.

A solution of boric acid, nitrate of silver (1 in 8,000), or protargol (1 in 1,000) may be used. The ureteric catheter is passed and the contents of the pelvis run off. The solution is instilled very slowly by means of a ureteric catheter syringe, about ½ to 1 drachm being used at a time, and the fluid then allowed to flow out. The lavage may be repeated once a week.

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[1] For further details of the method and its use, the reader is referred to the following articles by the author: *Lancet,* June 17, 1911; *Medical Society's Transactions,* vol. xxxv, 1912.

CHAPTER II

THE REGIONAL ANATOMY OF THE KIDNEYS AND URETERS

By David Newman, M.D. (Glasg.)

ANATOMY OF THE KIDNEY

The measurements of the kidney may be stated as 4 inches in length, 2½ inches in breadth, and 1¼ inches in thickness. The left kidney is generally longer, narrower, and thinner than the right.

The kidneys are convex on the upper, lateral, and lower margins, and on their medial border they have a short abrupt concavity or notch —the hilus—into which the renal arteries enter, and through which the veins and ureters pass out. The anterior surface, while more round than the posterior, is somewhat like a flattened wedge. Frequently a prominence or rounded ridge extends across the anterior aspect, from which the surface slowly falls away obliquely, forming two indistinct planes. On the upper plane of the left kidney rest the stomach, the spleen, and the suprarenal gland; on that of the right, the liver. The lower planes press upon the intestines (large and small), especially the duodenum on the right side. They look slightly lateral, and are partly covered by peritoneum.

The posterior surface of the kidney is flattened, and is directed slightly medially as well as backwards. The posterior surface is not covered with peritoneum, but rests upon the twelfth rib on the right side and the two lowest ribs on the left; between the kidney and the transverse processes of the first and second lumbar vertebræ are interposed the anterior layer of the dorso-lumbar aponeurosis, the quadratus lumborum, and the psoas magnus muscles. Behind the kidney, but separated from it by the diaphragm, is the pleura, which descends as low as the upper surface of the twelfth dorsal vertebra and the lower margin of the eleventh rib.

The vascular supply to the kidney is very abundant. The right artery is longer than the left. Both arise from the aorta about the same level; the right artery passes behind the vena cava, and just before entering the hilus it passes between the ureter and the renal vein before breaking up into five or more branches, to be distributed to the substance of the kidney.

An anatomical fact of value to the surgeon was pointed out by Hyrtl,[1] namely, that the arterial supply to the anterior and posterior segments of the kidney are completely separate, and do not anastomose with each other. To this course and distribution of the renal arteries

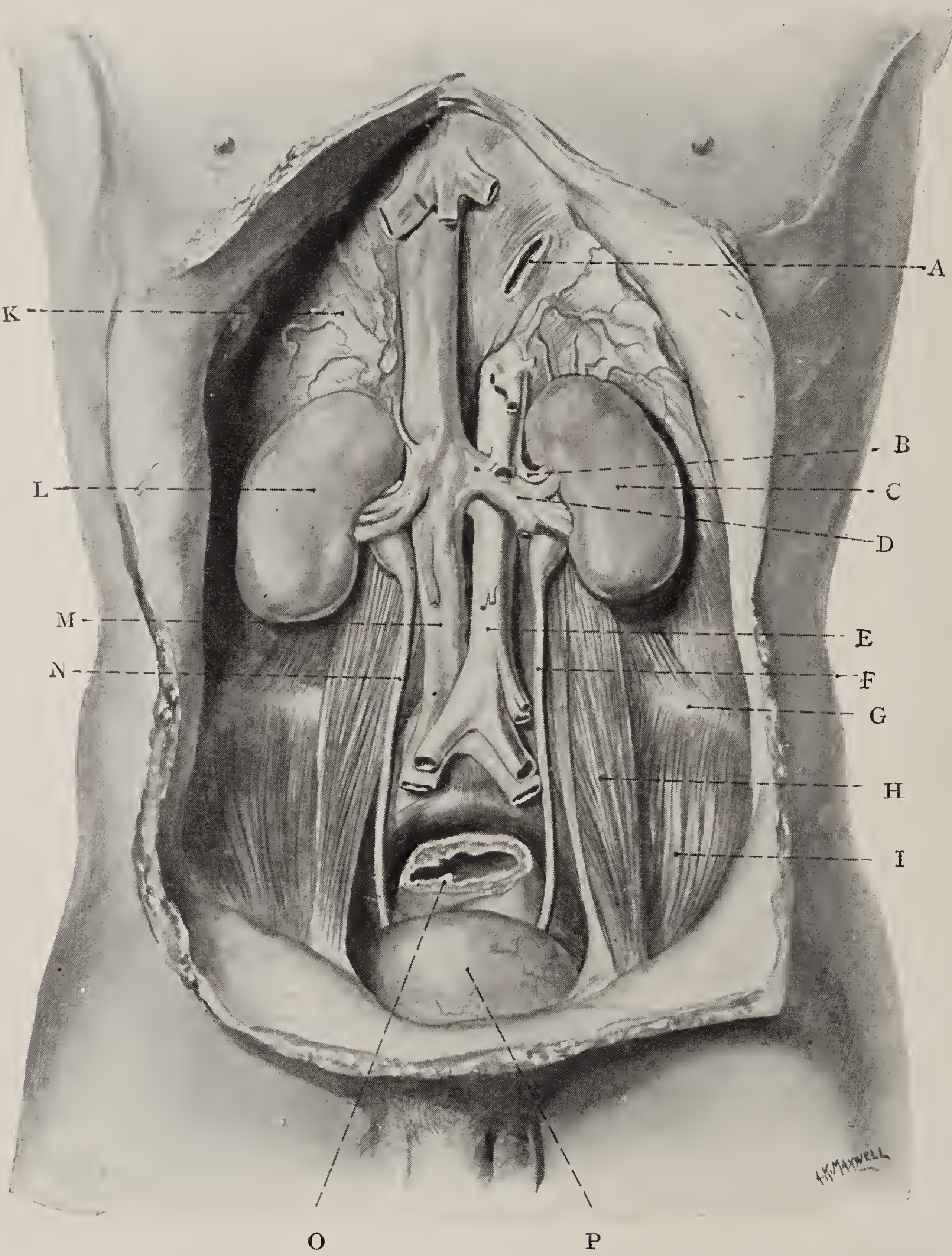

FIG. 259. THE RELATIONS OF THE KIDNEYS. Drawing showing anterior view of the kidneys, C and L, in position, and their relationship to the diaphragm, K, and the muscles of the back. H, Psoas magnus muscle, and I, Iliacus; G, Ilium, M, Vena cava, and D, Left renal vein; E, Aorta, and B, Left renal artery; N, Right, and F, Left ureters; P, Bladder, and O, Rectum; A, the opening in the diaphragm for the œsophagus.

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[1] Hyrtl, *Topograph. Anat.*, Wien, 1882.

attention has been redirected by Max Brödel.[1] The line of separation corresponds with the axis of the posterior row of calyces. This line is posterior to the summit of the convex border, and is about a third of an inch distant from it, and being the least vascular zone in the kidney it is now selected as the line of incision in exploring the pelvis of the kidney.

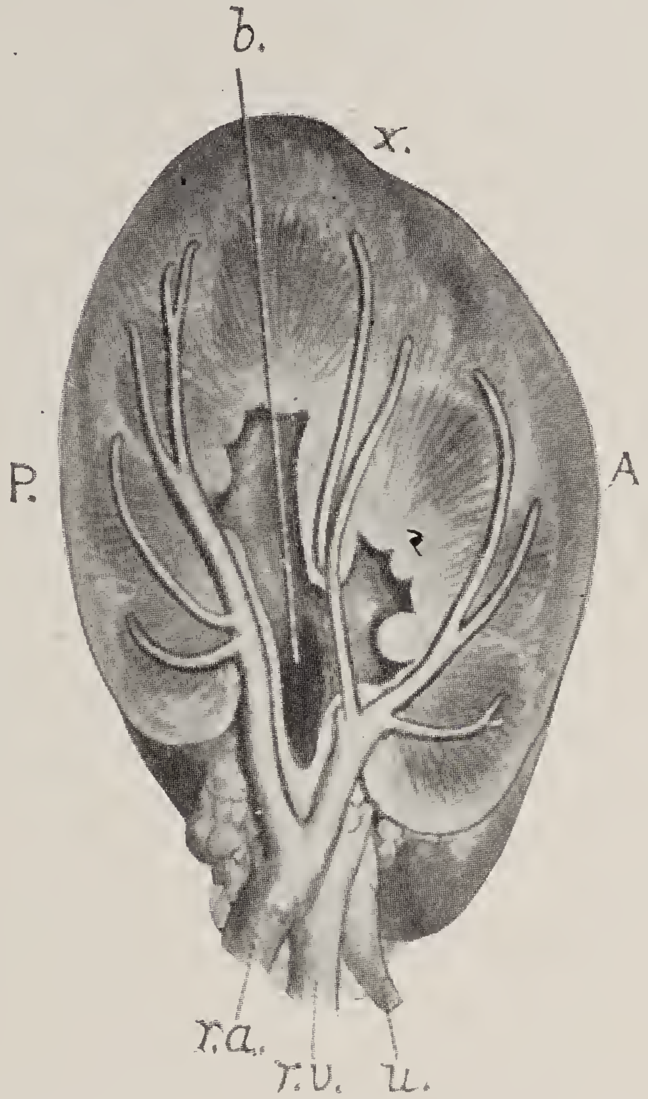

FIG. 260. HORIZONTAL SECTION OF THE KIDNEY SHOWING INCISION FOR EXPLORING THE RENAL PELVIS. The line *b* indicates the incision, half an inch posterior to the middle line of the convex margin of the kidney. *x*, The position of the longitudinal column which unites the two segments of the kidney—P, Posterior; A, Anterior, *r.a.*, Renal artery; *r.v.*, Renal vein; *u.*, Ureter. [This figure is reproduced by the courtesy of the publishers of the *British Journal of Surgery*.]

The adipose capsule is derived from the lamina fibrosa of the fascia propria peritonei, and is composed of loose tissue, which on reaching the kidney divides into two layers and contains a variable quantity of fat. Of these two layers, one passes in front of the kidney, between it and the peritoneum, to which it is united; the other extends behind the pelvis and vessels, is in close contact with the posterior surface of the kidney, contributes largely to the fixation of the organ, and has been termed by Barthol the 'ligamentum suspensorium renis.' The perirenal fascia has an anterior and a posterior lamella, and these join to be inserted into the diaphragm. Fat is deposited both in front of and behind the posterior lamella. According to Zuckerkandl, the perirenal fascia is strengthened on the left side by numerous bands, remnants of the primitive fusion of the descending colon and the parietal peritoneum. Owing to the difference in the relationship of the colon, this additional support is wanting on the right side. The perirenal fat differs in colour and density from that found elsewhere; it is of a finer texture and a bright yellow colour, and so can be distinguished easily from the subperitoneal fat.

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[1] Brödel, *Johns Hopkins Hosp. Bull.*, xii, No. 118.

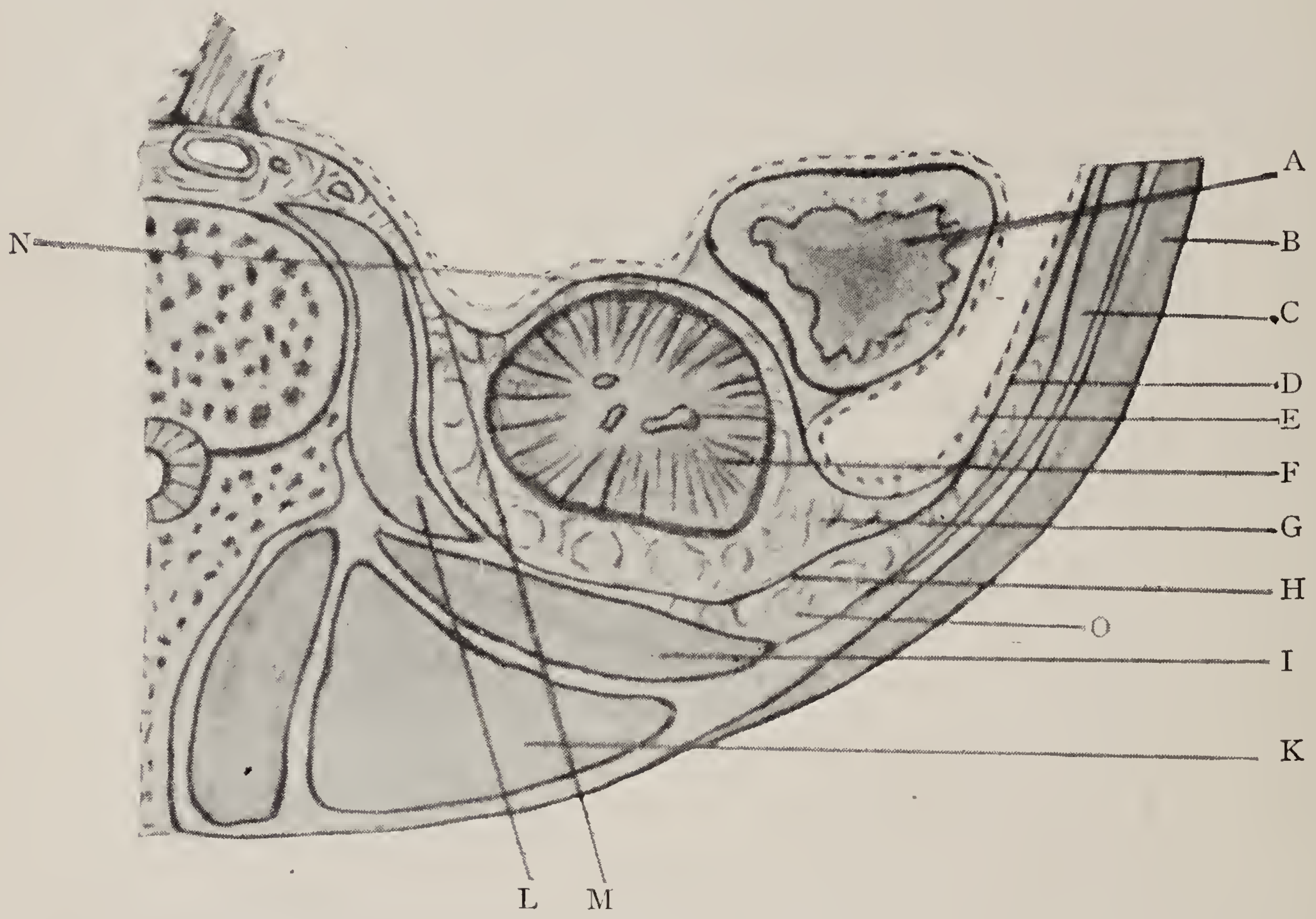

Fig. 261. Transverse Section through the Right Lumbar Region. a, Descending colon; b, Internal oblique; c, Transversus abdominis; d, Subperitoneal fascia; e, Peritoneum; f, Right kidney; g, Fat within the perirenal fascia; h, Posterior lamella of the perirenal fascia; i, Quadratus lumborum; k, Sacrospinalis; l, Psoas; m, Anterior lamella of the perirenal fascia; n, Fat between the perirenal fascia and the kidney; o, Fat behind the perirenal fascia.

In health one always finds the organ closely packed in adipose tissue (see Figs. 261 and 262), so that the retro-renal fascia (h) can be exposed only by cutting through a deep layer of fat (o) lying posterior to it, and, after dividing the fascia, the firm fat (g) must be torn away before the kidney is reached. In movable kidney, while a considerable amount of fat remains, it is loosely bound together.

The perirenal fascia, which in health is a thin prolongation of the subperitoneal fascia (see Figs. 261 and 262), is the most important structure employed in retaining the organ in its normal position; divided into two lamellæ—the anterior (M) and the posterior (H)—the fascia in normal conditions is embedded in fat, the layer in front of the kidney (N) being thin, while that lying posteriorly (O) is usually thick.

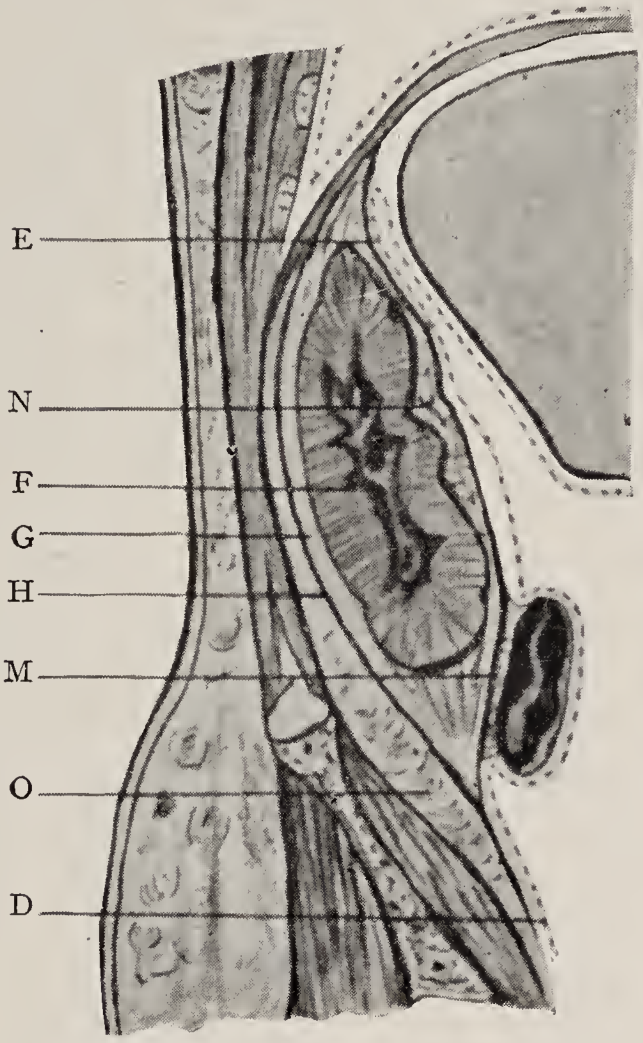

FIG. 262. VERTICAL SECTION THROUGH THE RIGHT LOIN. D, Subperitoneal fascia; E, Peritoneum; F, Right kidney; G, Fat within the perirenal fascia; H, Posterior lamella of the perirenal fascia; M, Anterior lamella; N, Fat between the anterior lamella and the kidney; O, Fat behind the perirenal fascia.

The kidneys are retained in position by the vessels which pass to and from them. The right kidney is generally situated a little lower than the left, probably as a consequence of the vicinity of the large right lobe of the liver. The kidneys are placed on either side of the vertebral column, about the level of the last dorsal and upper two lumbar vertebræ; their position, however, is very liable to variation, both in health and in disease, and also according to the conformation of the skeleton. Their relative distance from the spine, or their position in relation to other organs, is observed to vary considerably.

As a rule, the pelvis of the right kidney is situated on a level with the first lumbar vertebra or immediately in front of the lowest limit of the last rib, while the pelvis of the left kidney is about 1 inch or 1½ inches higher up. Fig. 263 shows the position of the kidneys in relation to the parts in the abdomen posterior to the peritoneum.

ANATOMY OF THE URETERS

The excretory duct of the kidney commences in the calyces; these unite to form a large funnel-shaped dilatation, the pelvis, which, passing downwards and inwards from the hilus, gradually assumes a cylindrical shape, and, decreasing in lumen, reaches the level of the lower end of

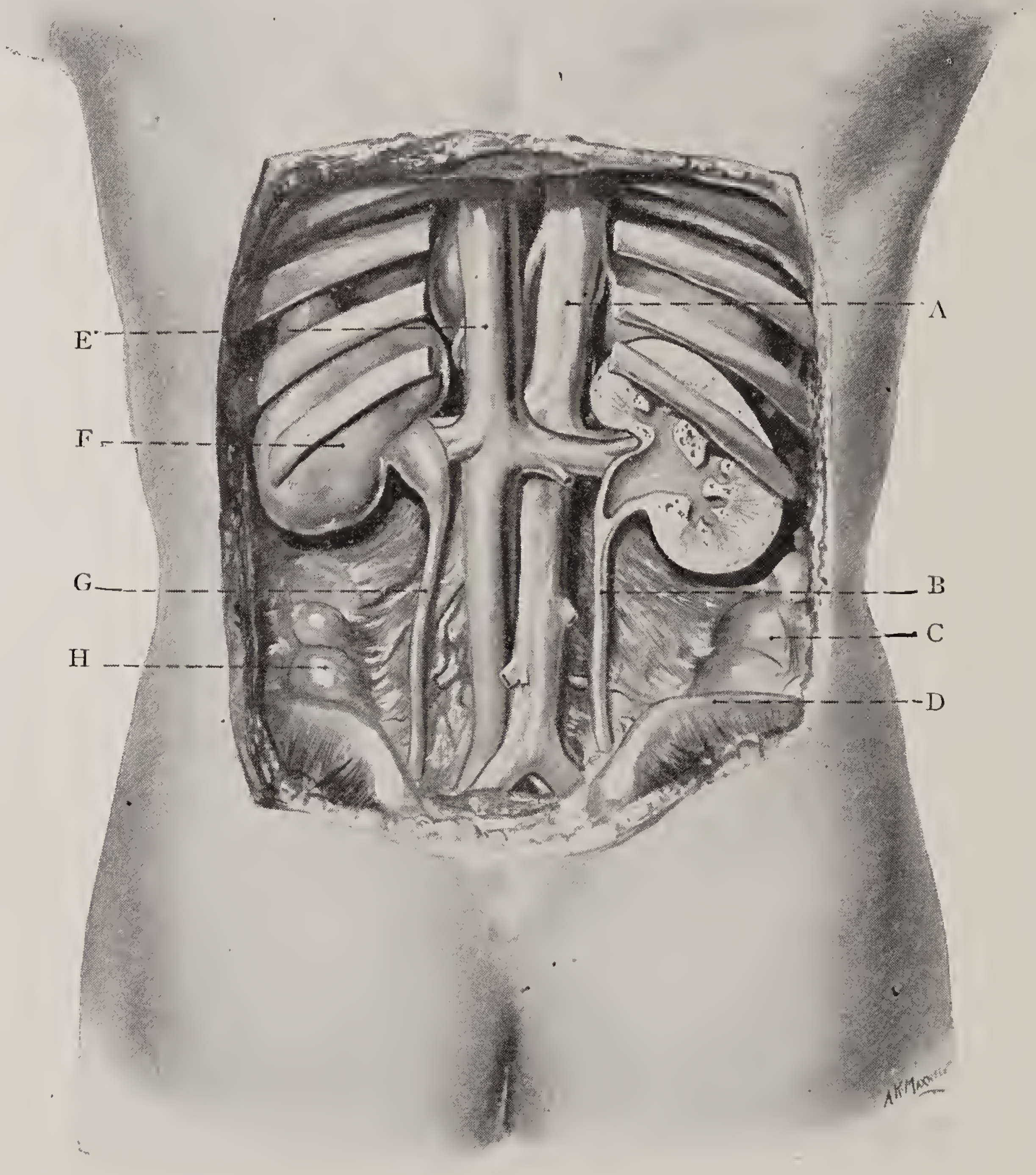

Fig. 263. The Posterior Relations of both Kidneys. The left kidney is entire. The pelvis of the right kidney has been opened, and the posterior half of the organ removed; E, the aorta, and A, the vena cava; B, the right, and G, the left ureter; C, the ascending, and H, the descending colon; F, the left kidney in its relationship to the eleventh and twelfth ribs, and D, the crest of the ilium.

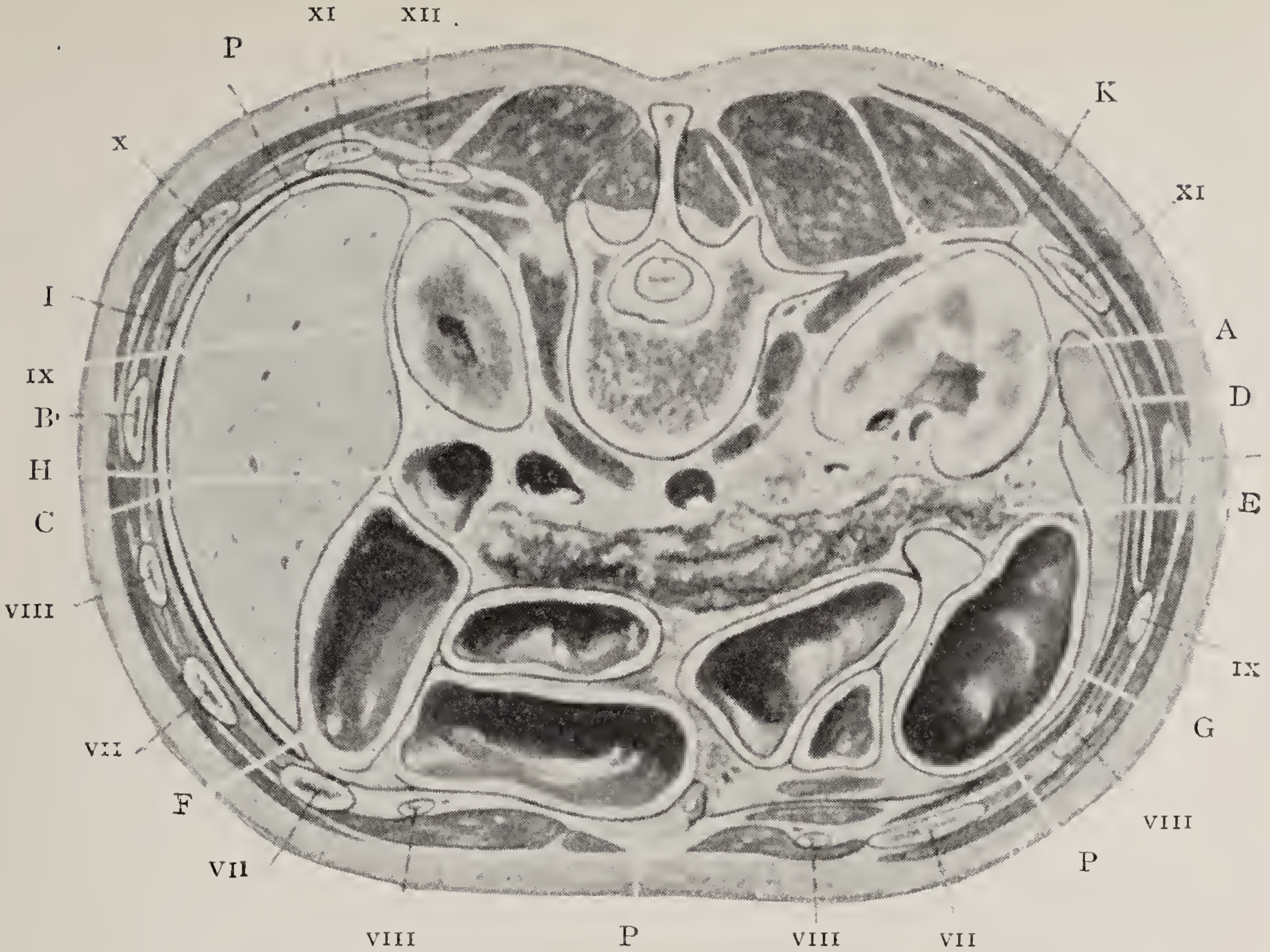

Fig. 264. Horizontal Section of the Abdomen at the Level of the First Lumbar Vertebra. Showing the relationship of the kidneys to other organs. a, the left kidney; k, the pleura immediately behind it; and d, the spleen on its outer side; in front are e, the tail of the pancreas, and g, the descending colon. b is the right kidney, with c, the liver, to the right of it; h, the duodenum, and f, the ascending colon, in front; behind, the pleura, i, does not come so close to the right kidney as it does to the left; p, the peritoneum. The numerals VII–XII refer to the corresponding ribs and costal cartilages.

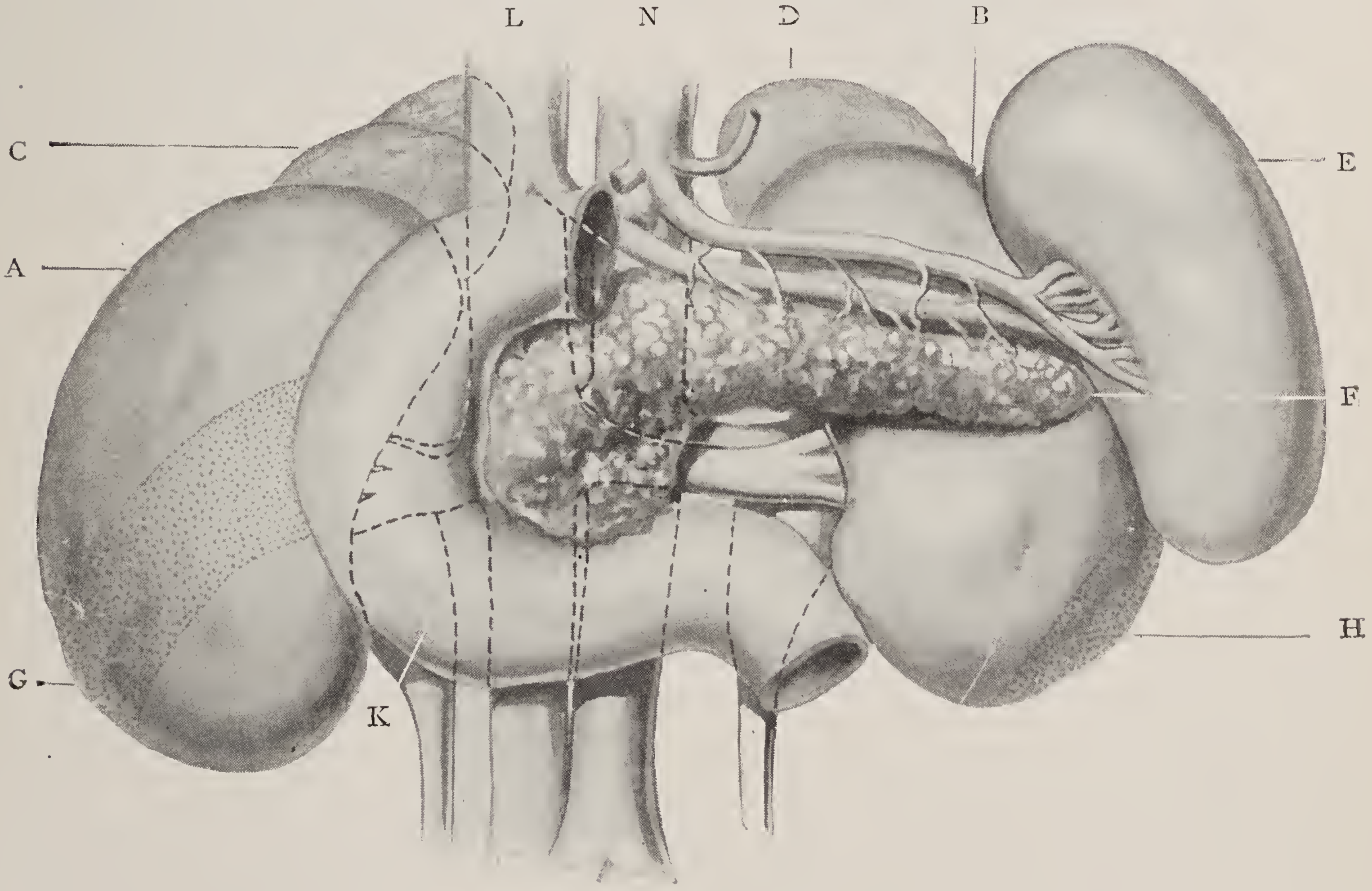

Fig. 265. The Relationship of the Kidneys to other Organs. Anterior view. a, Right kidney covered in front by k, the duodenum, and g, the colon, and above by c, the suprarenal gland. b, The left kidney, covered in front by e, the spleen, by f, the tail of the pancreas, and by h, the colon; e, the suprarenal gland. l, Vena cava; n, Aorta.

the gland to form the ureter. This cylindrical membranous tube is about the diameter of a goose-quill, and from 16 to 18 inches in length. Its lumen, however, is not uniform. In normal conditions it is seen to be narrowed in three places: (1) at a point 1½ to 2 inches below the pelvis of the kidney, (2) at the point where it crosses the common iliac artery, and (3) just as it enters the wall of the bladder. The ureter is placed at the back of the abdomen, behind the peritoneum, and passes obliquely downwards and medially and enters the cavity of the small pelvis. It then passes downwards, forwards, and medially to its insertion into the base of the bladder. The line of the ureter follows several curves and may be described as sigmoid. Above the pelvis there is a slight convexity towards the median plane, while the portion within the small pelvis is strongly curved with its convexity directed laterally towards the side of the pelvis until it reaches the wall of the bladder, when the convexity becomes directed laterally and backwards.

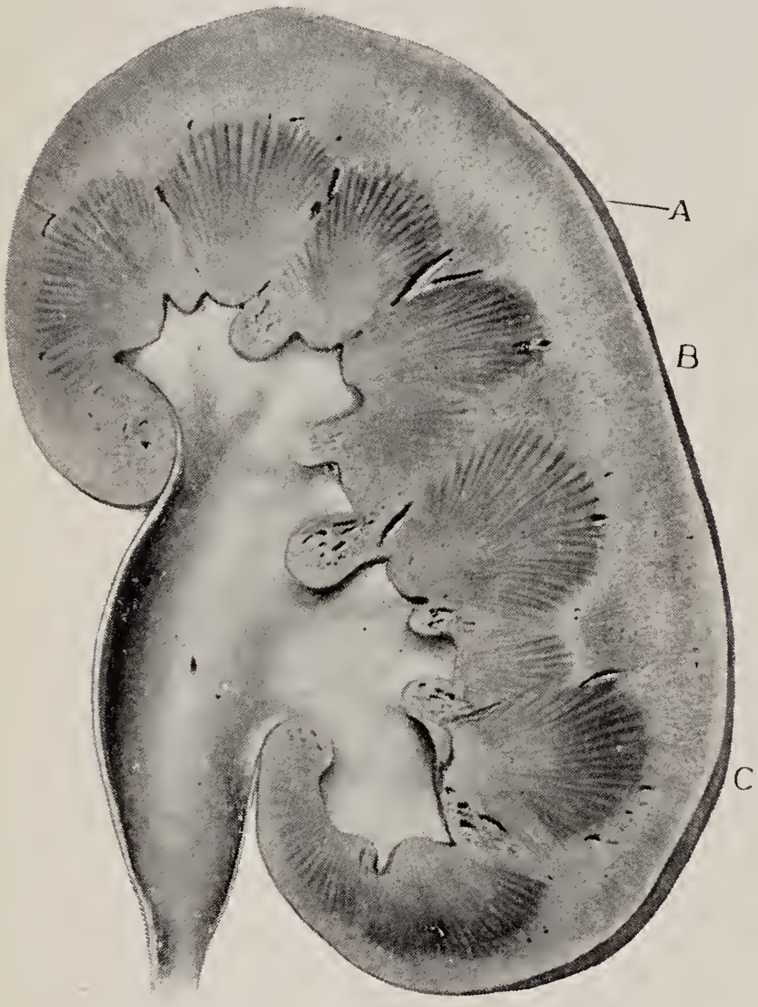

Fig. 266. Vertical Section of the Left Kidney. The left kidney enclosed in A, dense fibrous capsule, B, the cortex, and C, the medulla, which passing inwards becomes narrower and terminates in the papillæ; these protrude into the calyces, which have been laid open, also the pelvis.

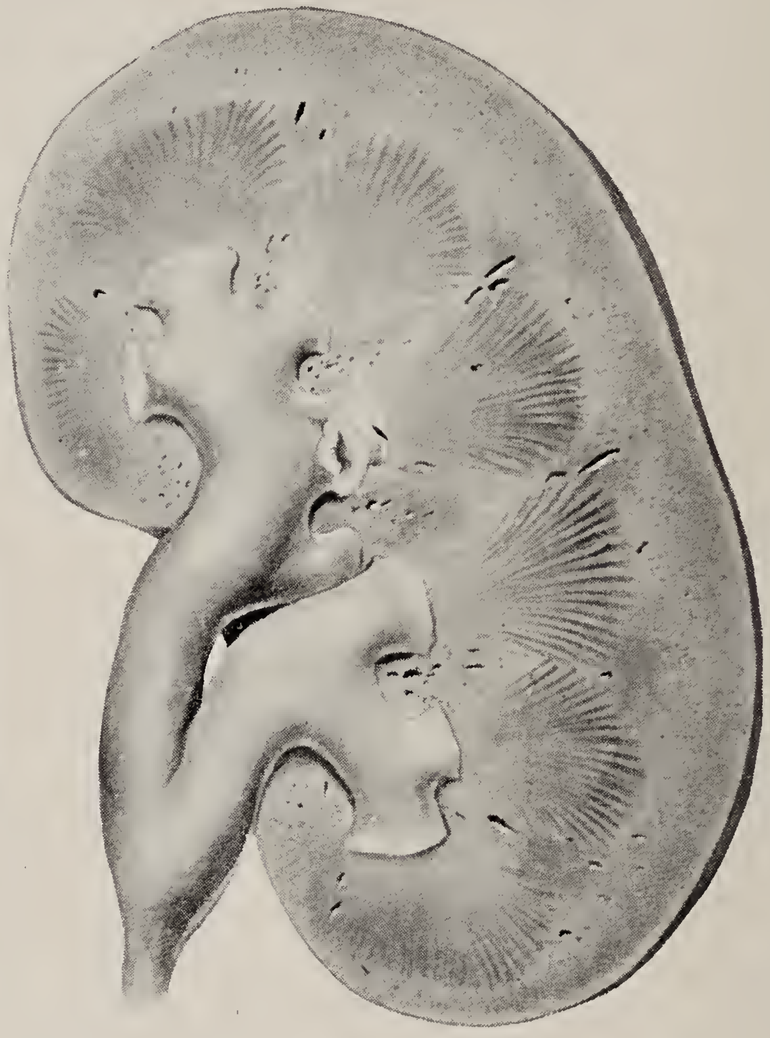

Fig. 267. Kidney with a Bifid Pelvis. The drawing shows most of the calyces unopened and their relationship to the papillæ.

From above downwards the ureter has the following relationships: It rests upon the psoas muscle and the genito-femoral (genito-crural) nerve, and is crossed in front by the internal spermatic vessels. The right ureter lies close to the lateral side of the inferior vena cava, but may get in front of it, and at the brim of the pelvis it crosses the external iliac vessels; the left ureter crosses the common iliac vessels. Opposite the sacrum, the ileum is in front of the right ureter, and the sigmoid colon in front of the left ureter; then, passing behind the fold of peritoneum forming the posterior false ligament of the bladder, the ureter runs below the obliterated umbilical (hypogastric) artery, the ductus deferens (vas deferens) in the male, and alongside the cervix uteri and upper part of the vagina in the female. It then traverses the wall of the bladder obliquely for a distance of about 1 inch, lying in the male about 1½ inches behind the base of the prostate and the posterior angle of the trigone, where it opens on the inner surface of the bladder by a narrow slit-like orifice, 3 millimetres long, which has a horseshoe-shaped elevation around it, except on the medial side. The manner in which the ureter passes through the wall of the bladder, while allowing the urine to flow freely downwards, effectually prevents any reflux from below upwards. The orifices are about 1 inch apart, when the bladder is moderately distended.

The lumen of the duct varies slightly. The narrowest part is where it passes through the wall of the bladder, and at the internal opening, which corresponds to the sphincter. There may be slight constriction immediately below the pelvis of the kidney. With these two exceptions, the ureter may be described as fairly uniform in calibre.

CHAPTER III

OPERATIONS FOR EXPOSURE OF THE KIDNEY: NEPHROPEXY: RENAL DECAPSULATION

Indications. Direct exploration of the kidney is justifiable under the following circumstances:

(i) To determine the condition of the opposite kidney before a nephrectomy.

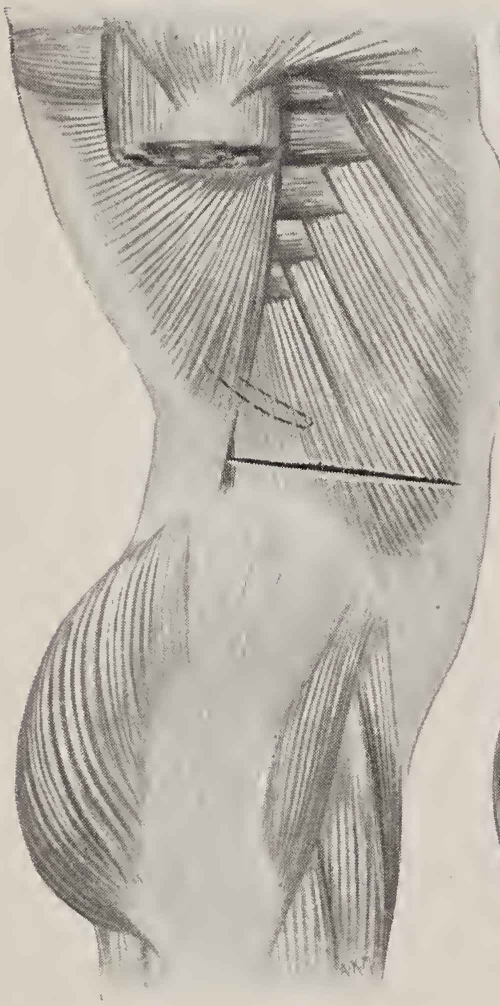

Fig. 268. Péan's Incision for Exposure of the Kidney.

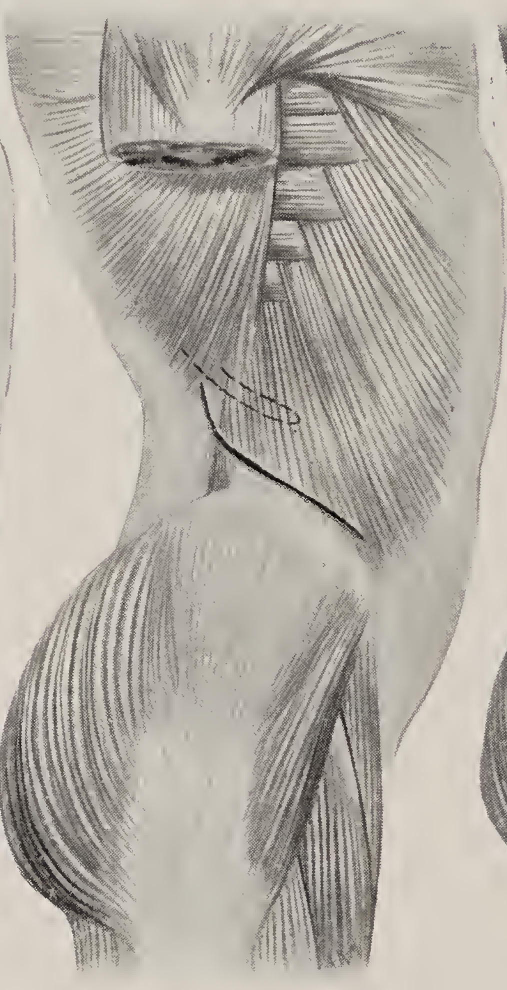

Fig. 269. König's Curved Lumbar Incision for Exposure of the Kidney.

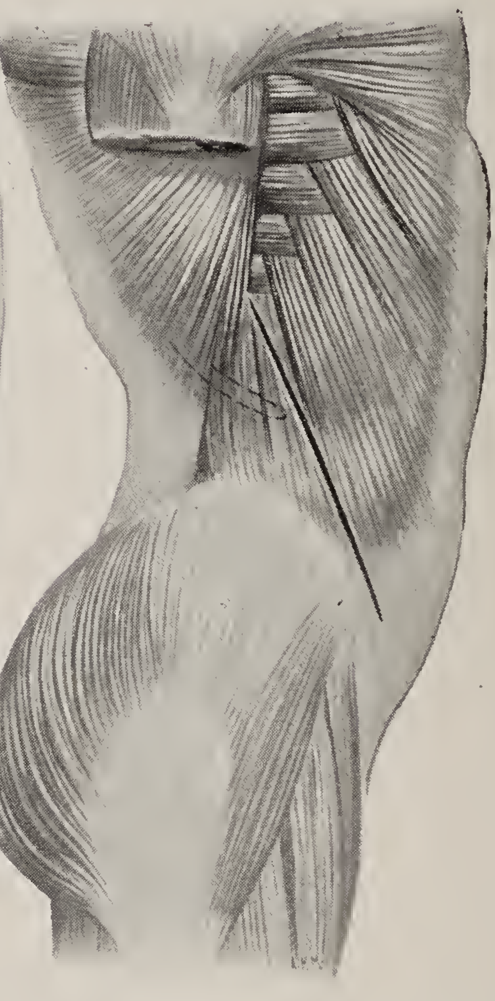

Fig. 270. Von Bergmann's Oblique Incision for Exposure of the Kidney.

(ii) In traumatic lesions of the kidney giving rise to grave symptoms.

(iii) In cases of sudden anuria, where medicinal treatment has failed.

(iv) In cases of doubtful diagnosis, especially suspected malignant tumours, tuberculous disease, or calculous disease with sepsis, or for the relief of tension due to mechanical congestion, inflammatory hyperæmia, or subcapsular extravasation of blood.

Operation. The first step in all operations upon the kidney is to expose it, and this may be done from behind by a retroperitoneal incision, or from the front by a transperitoneal operation, according to the amount of space required.

Lumbar or retroperitoneal operations. The incision selected to expose the kidney depends upon the amount of space that can be obtained in the individual case, and the condition of the kidney in respect to size.

The vertical incision. With a sand-bag or firm pillow placed on the table so as to support the abdomen the patient is laid face downwards and the spine made to arch upwards. The incision starts at the junction of the sacro-spinalis muscle and the twelfth rib, and passes downwards along the lateral border of the muscle. This line of incision is not suitable to give a free exposure of the kidney, but has been much used in performing nephropexy.

The transverse incision (Fig. 268). With the patient lying on his back the incision is made along a line at the level of the umbilicus from the sacro-spinalis to the rectus abdominis.

The curved lumbar incision, or the oblique one is now almost exclusively used, as these give the best access to the kidney, and if more space is required it is easily got by extending the incision downwards and inwards. Hence, it has been recommended to make a vertical incision from the lowest rib to the crest of the ilium, and if more room be required, another cut is made in the parietes to join this one either at its upper or lower limit. These second incisions may be made in one of two ways—firstly, beginning at the upper limit of the vertical wound, by making a cut parallel to the last rib and extending it downwards and forwards; or, secondly, the incision may be made from the lowest point of the vertical wound, and extended forwards at right angles to it and parallel to the iliac crest. In making these or other incisions which may be suggested in the course of the operation, care must be taken not to go too near

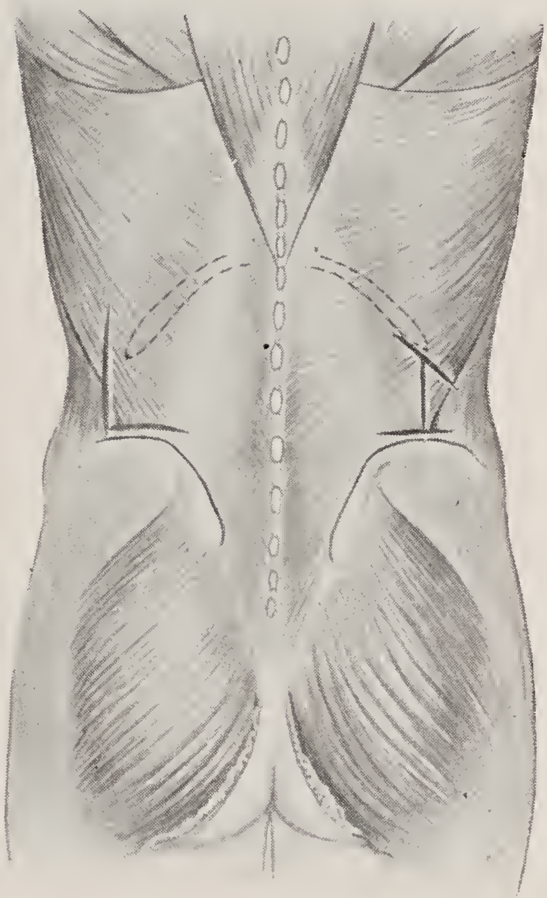

Fig. 271. Bardenheuer's Incisions for Lumbar Nephrectomy.

to the twelfth rib, as the diaphragm sometimes extends downwards from it, and the pleura may be injured by free incision in this direction (Figs. 269–71).

The patient is made to lie on his healthy side with the leg straight, while the thigh on the affected side is bent at a right angle to the trunk and the knee flexed and well elevated on a sand-pillow. The flexion of the knee prevents the patient from rolling round on the table during the operation. The operating table I now use is constructed with a transverse iron platform running across it. The platform can be elevated according to the requirements of the patient. A soft hair cushion is placed between the iron plate and the patient, or what is equally good for the purpose, an air-pillow consisting of three separate compartments under the opposite flank, distended so that at first the pelvis does not rest on the table. By opening the screw valves in the two lower segments of the pillow the air is allowed to escape until the pelvis just touches the table; the valves are then closed.

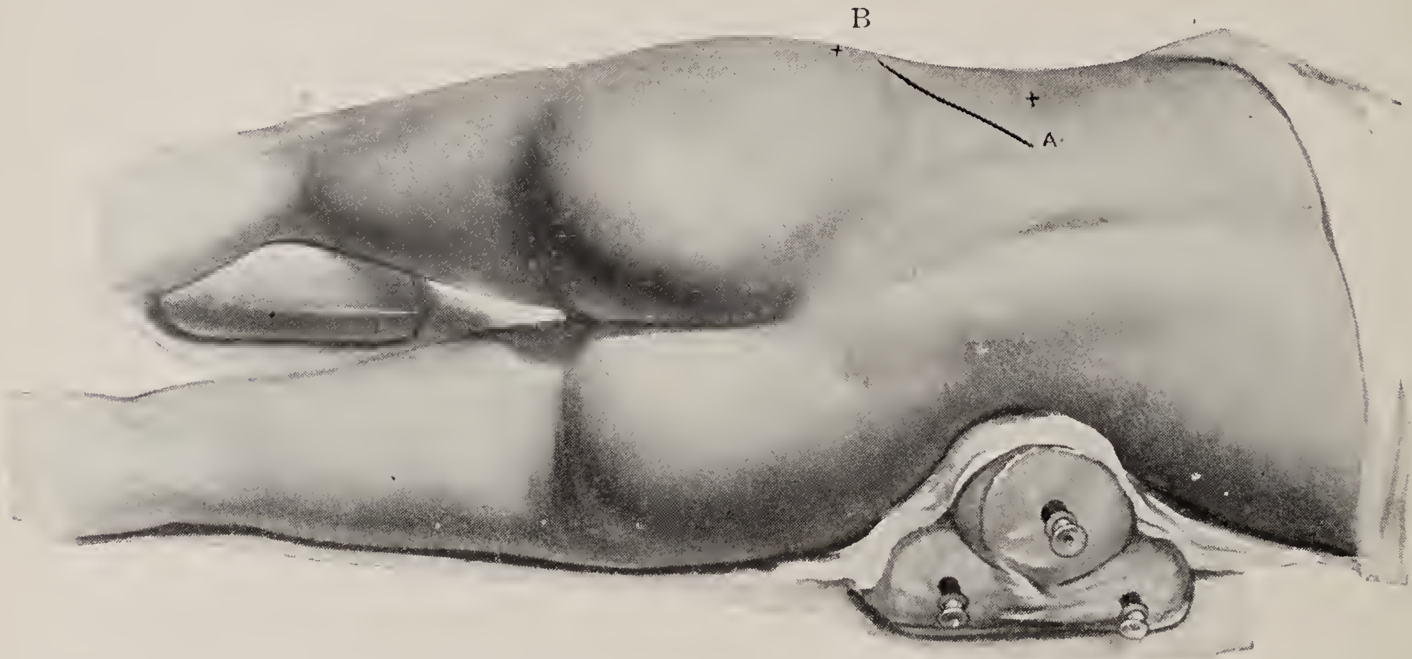

FIG. 272. POSITION OF THE PATIENT FOR EXPOSING THE KIDNEY. The + on the right-hand side is over the tip of the last rib; the other is over the centre of the crest of the ilium. The line A B is that of the incision when the space is large.

The surgeon, having defined the position of the lowest rib and the crest of the ilium, knows the space at his disposal. The ilio-costal space varies greatly, however, being sometimes 2½ to 3 inches, in other cases only a finger's breadth; hence the direction of the incision must vary according to the individual circumstances. As a rule, *when the space is small,* the incision should be similar to that adopted for Amussat's lumbar colotomy. A line is drawn from the centre of the crest of the ilium to the free extremity of the last rib, and at right angles to the centre of this an incision is made from the lateral border of the sacro-spinalis muscle, forwards for a distance of 3 or 3½ inches, according to the size of the abscess, sac, or cyst.

When the space is large, the line of incision is from the point where the quadratus lumborum meets the lower edge of the last rib downwards and forwards to a point on the crest of the ilium 2½ inches posterior to the anterior superior spinous process (see Figs. 272 and 273). The skin, fascia, &c., being divided, the latissimus dorsi and the edge of the external oblique muscles are seen, and should be divided in the same line as the incision through the superficial tissues (see Fig. 273). The internal oblique muscle and the dorso-lumbar fascia are thus exposed, and must be carefully divided, when the adipose capsule of the kidney is brought into view.

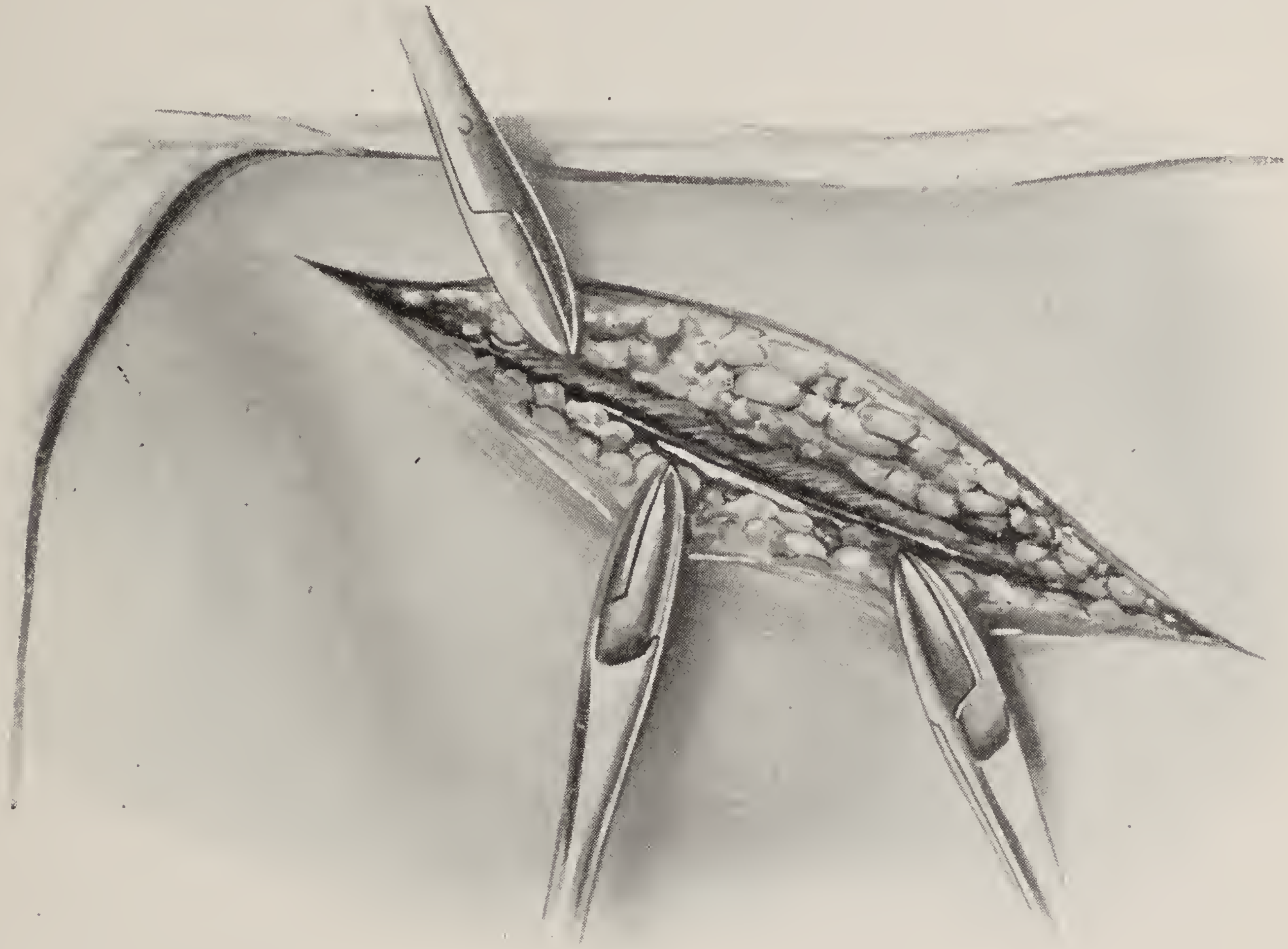

FIG. 273. SUPERFICIAL INCISION FOR EXPOSING THE LEFT KIDNEY.

Freeing and delivery of the kidney is accomplished by introducing the forefinger of one hand between the fatty capsule and the fibrous covering of the kidney on its posterior aspect, the palmar surface of the finger being next the kidney. The fatty capsule having been completely freed from the posterior surface, the forefinger of the other hand is used in a similar way to free the capsule from the anterior aspect, or the two forefingers may be employed together, one on either side of the organ. When the kidney is movable or free from inflammatory adhesions the stripping of the fatty capsule is easy. Caught between the two forefingers the kidney should be drawn down, and the lower pole delivered first. Steady traction is required, but force should be avoided. The lower pole should be hooked out and held in position with a sponge-holder covered with rubber-tubing, while the forefinger is passed upwards under the upper pole, which is gradually eased downwards, lifted out of its cavity, and hitched over the twelfth rib. If there is sufficient space, the whole hand may be introduced through the wound.

In most cases delivery of the kidney can be effected easily if the kidney be not greatly enlarged, the ilio-costal space unduly small, or the parietes unusually thick; but should the conditions prevent the organ being exposed to view, either the space must be enlarged by dividing the twelfth rib subperiosteally and freely incising the quadratus lumborum or the kidney must be examined *in situ*.

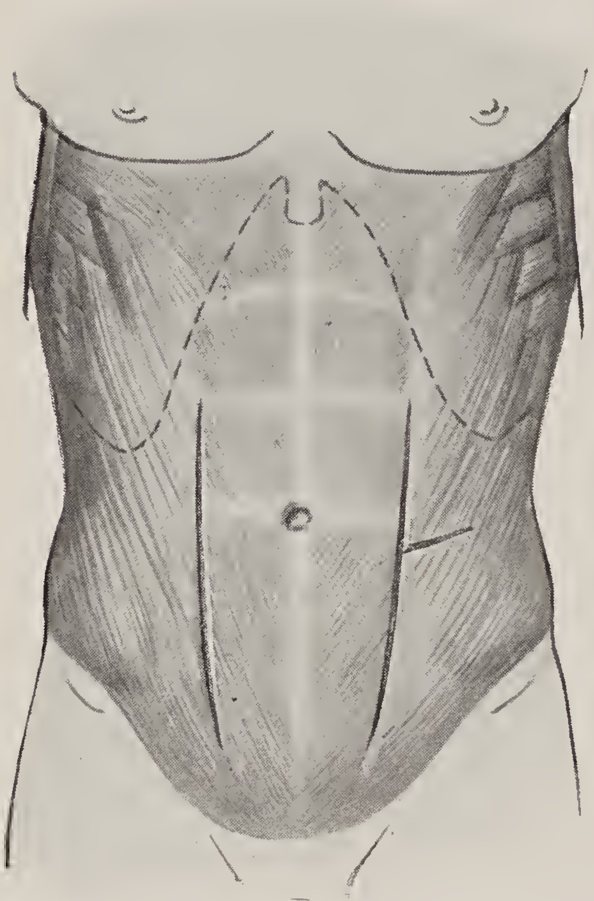
Fig. 274. Langenbuch's Incision for Transperitoneal Operation.

Difficulties. The difficulties met with in exposing the kidney by lumbar incision are: (1) A narrow ilio-costal space; (2) a thickly-set trunk with fat parietes; (3) rigidity and thickening of the lumbar muscles; (4) inflammatory adhesions around the kidney, causing matting of the parts, induration of the kidney, and adhesion of the fatty capsule; (5) flatulent distension of the colon, causing the bowel to protrude backwards; (6) a high position of the kidney, the entire organ being placed above the level of the twelfth rib; (7) downward displacement of the kidney below the crest of the ilium; (8) atrophy of the kidney, the wasted organ being enclosed in a dense mass of fat.

The lateral abdominal operation (Langenbuch's). This is performed as follows: The patient being placed upon his back, an incision is made in the linea semilunaris on the side of the diseased kidney (see Fig. 274). The length of the incision in the parietes is regulated by the size of the organ to be removed. The cavity of the abdomen is opened, and the intestine which protrudes having been pushed aside, a careful examination of the diseased kidney and its fellow is made. If the other kidney be presumably able to do its work, the next step is to expose the posterior or lateral layer of the mesocolon, by pushing aside the intestines. The mesocolon is then incised vertically, and an opening is made of sufficient size to admit one or two fingers (see Fig. 275).

The anterior lips of both peritoneal wounds, that of the abdominal wall and that of the mesocolon, should now be united by closely set sutures of catgut, for the purpose of shutting off the cavity of the peritoneum from the space occupied by the kidney. Langenbuch's purpose was to divide the outer layer of the mesocolon, so as to reduce the risk of hæmorrhage and gangrene of the bowel. When the peritoneum has been stripped off by the finger, and the kidney freed from its surroundings, the organ may be dealt with as required.

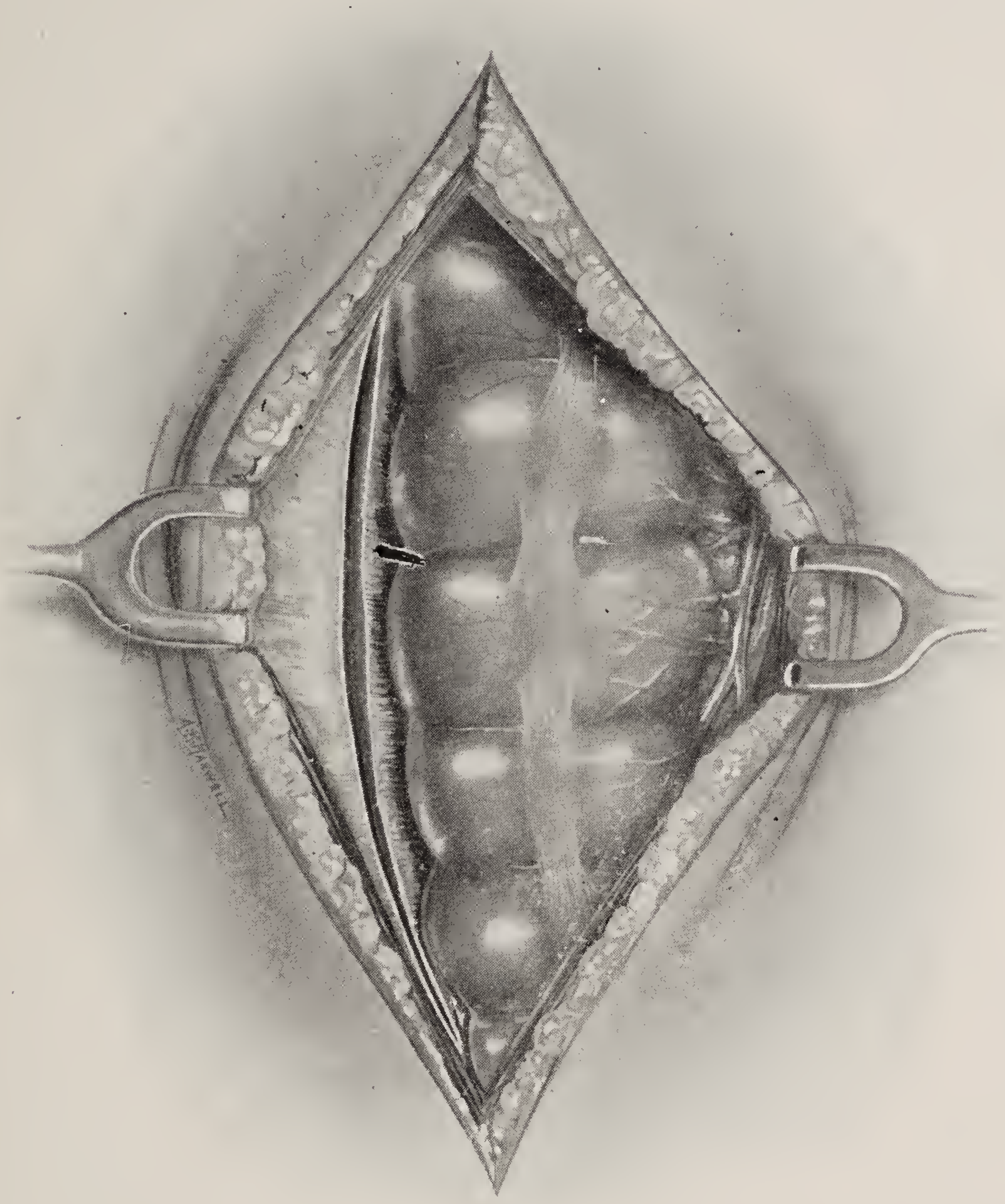

Fig. 275. Incision in the Lateral Layer of the Mesocolon in Transperitoneal Operation on the Right Side.

The median abdominal operation. The incision is similar to that for ovariotomy. When access to the abdominal cavity has been gained by a section through the linea alba, the principal difficulty to contend with is the hæmorrhage, which is apt to occur as a consequence of incision or laceration of the large veins in the anterior layer of the mesocolon. The operation is more easily performed on the right than on the left side, for the reason that the mesocolon of the descending colon is shorter and lies more laterally and deeper than that of the ascending colon. The incision in that structure should be made in the line of the veins, and if it be found necessary to divide any of these vessels, they should be previously secured by ligatures. When the kidney has been thus safely reached, the remaining steps of the operation are the same as in Langenbuch's.

By suturing the cut edges of the mesocolon to the abdominal wound, the operation may be practically rendered an extra-peritoneal one.

NEPHROPEXY

Indications. Nephropexy should be recommended:

(i) In all cases of uncomplicated movable kidney in which the pain is distinctly renal—in which renal crises occur repeatedly, are well marked, and are referable to a definite cause.

(ii) Where there is evidence that the displacement causes twisting of the pedicle of the kidney, as indicated by paroxysmal renal pain, and the presence of such abnormal constituents in the urine as albumin, blood, pus, or tube casts.

(iii) When gastro-intestinal symptoms are pronounced while the patient is active, but relieved while she is at rest.

The operation should not be recommended when the symptoms distinctly referable to the mobility of the kidney are a small part of the trouble.

In movable kidney complicated by enteroptosis, an operation should not be recommended unless it can be shown clearly that serious symptoms are directly due to the displacement of the kidney. For example, in a case of general relaxation of the abdominal walls following frequent pregnancies, where the whole of the contents of the abdomen occupy a lower and more anterior position than normal, associated with chronic dyspepsia, constipation, and symptoms of uterine displacement and perhaps with hernia and hæmorrhoids, nephropexy should not be performed unless the displacement of the kidney is causing symptoms of torsion of the pedicle.

When movable kidney is associated with a highly nervous temperament, all palliative means should be employed before suggesting an operation. When the neurotic phenomena are due to pressure of the kidney on other abdominal organs, the question of nephropexy may be considered.

When long-standing dyspepsia and chronic constipation are present, or when chronic uterine or ovarian disease or cystic or chronic organic disease of the kidney coexists with mobility of the organ, nephropexy should not be performed, nor should it in those cases in which the displacement does not give rise to much discomfort or functional disturbance, the mobility of the organ being discovered probably by accident.

Operation. The methods of operation may be divided into two classes: those in which the operation is performed without, and those in which the operation is performed with decapsulation.

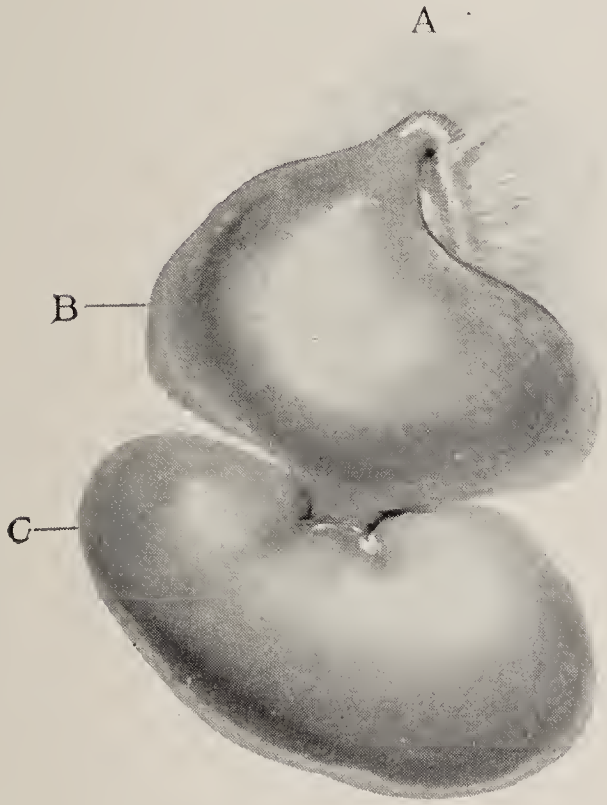

Fig. 276. Sudden Bending of the Ureter, a, causing Hydronephrosis, b, in a Movable Kidney, c.

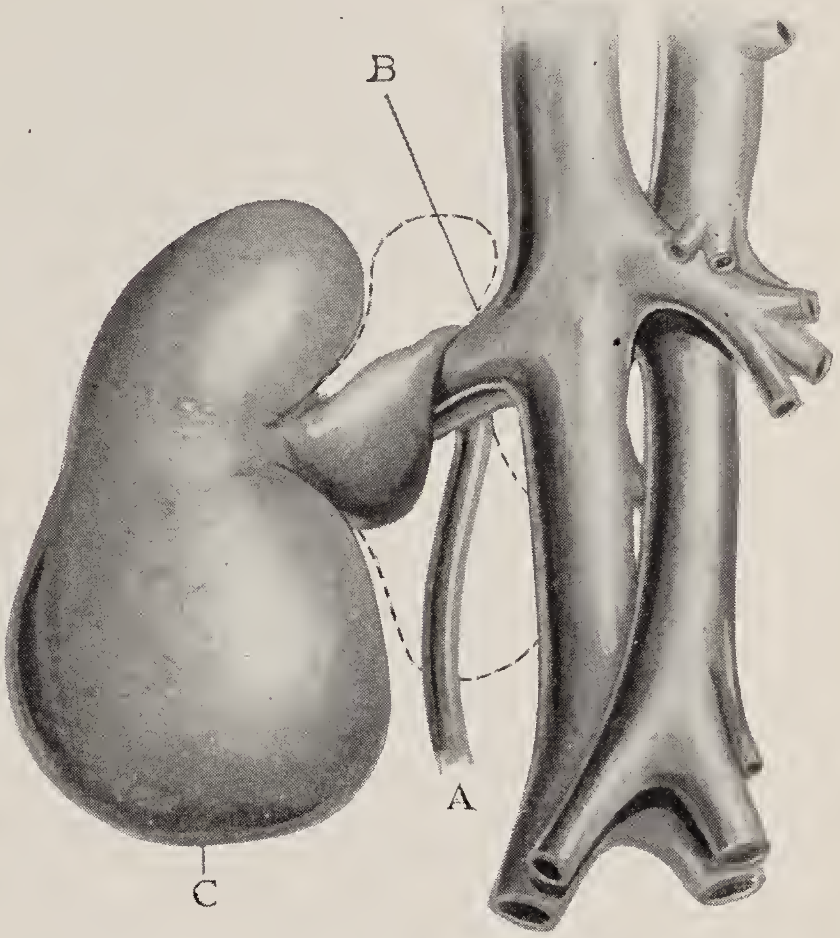

Fig. 277. Rotation of a Movable Kidney. The ureter, a, is twisted round the vessels, b. The upper pole, c, is inverted.

The preliminary stages of the operation are the same as for lumbar exploration (see p. 549).

Methods without decapsulation. Many early nephropexies were performed without removing the capsule; but, as the operation frequently proved ultimately unsuccessful, this method has been practically abandoned.

In a few of his earlier cases the writer simply removed the whole of the perirenal fat (in a small proportion of these, laid bare the surface of the quadratus lumborum and psoas muscles) and packed the space around the kidney with gauze. The skin and subcutaneous tissue were accurately sutured over the plug of gauze except at the posterior end, where an opening was left, with the gauze lying in it, so as to act as a drain and to allow of its withdrawal. The gauze was allowed to remain *in situ* for eight or ten days for the purpose of causing any remaining adipose tissue to break down and be discharged, also in order to excite adhesive inflammation. When the gauze was withdrawn on the eighth or tenth day, the cavity of the wound was irrigated, and a small strip of gauze or drainage tube inserted. The principle on which this method is based is that the broad band of fibrous tissue developed between the organ and the parietes is more likely to anchor the kidney firmly than when healing by primary union is aimed at.

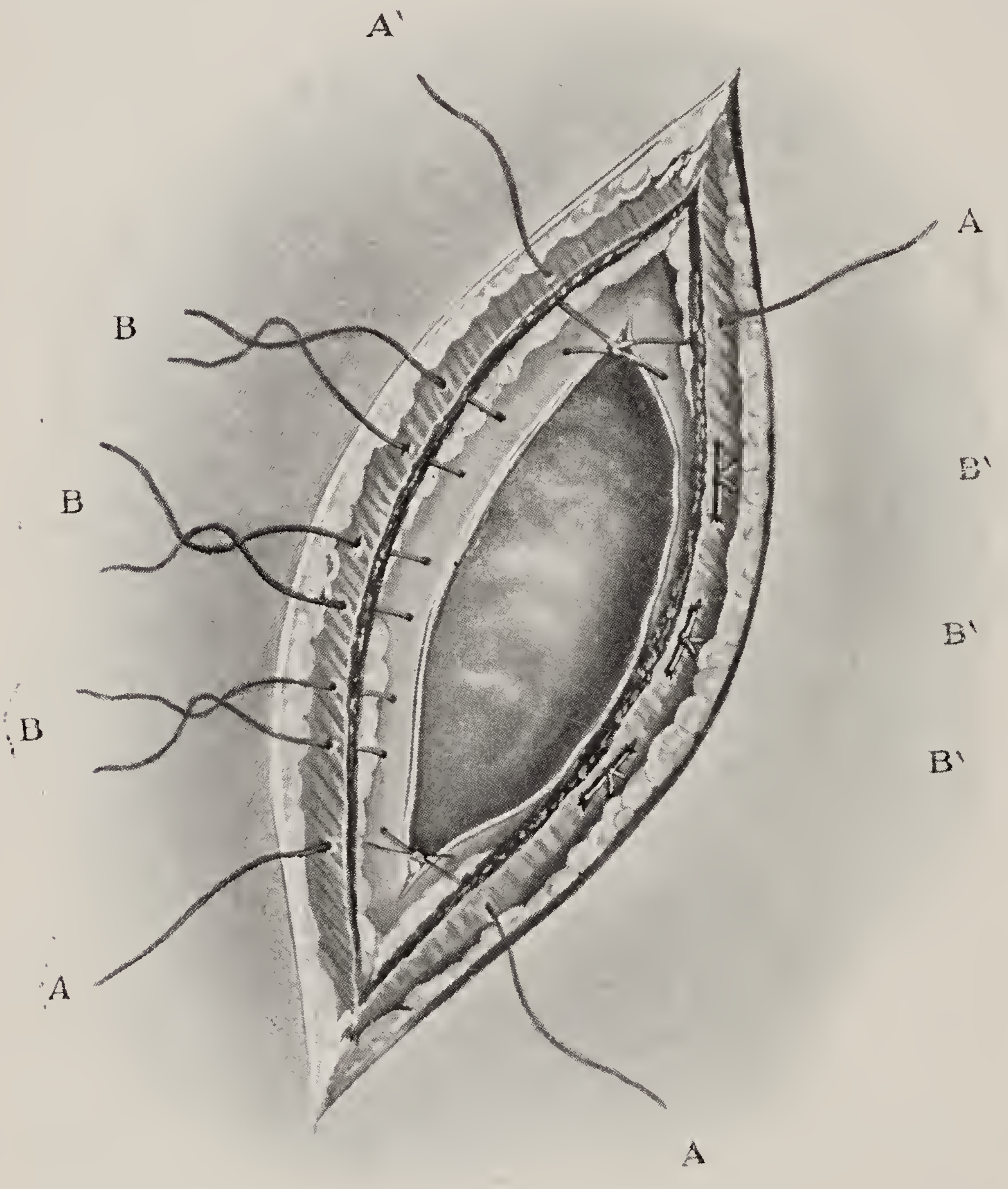

Fig. 278. Method of suturing the Capsule of the Kidney to the Muscular Parietes.

Methods with decapsulation. In the great majority of cases the writer has found it necessary to separate the fibrous capsule covering the convexity of the kidney.

After the kidney has been exposed the adipose capsule is removed along the convex border, one catgut suture is passed through the cortex at the lower, and another at the upper pole of the kidney, A A, so as to fix the organ between the deep lips of the wound. The fibrous capsule is then incised and peeled off, so as to expose the raw surface of the cortex and the cut edges are sutured to the muscular parietes (see Fig. 278, B B'). The sutures through the cortex are then fixed to the deep aponeurosis, the muscular wall is stitched in separate layers, the skin united by silkworm-gut, and the wound allowed to heal by first intention, no drainage tube or packing being employed.

Tuffier separates a portion of the capsule from the posterior surface of the kidney, folds the fibrous capsule back, and exposes an area of the cortex. Through the reflected capsule he passes eight sutures, four on each side, and these, after penetrating the capsule, transfix the cortex so that the reflected folds of capsule are kept widely apart. The sutures are then passed through the edges of the wound in the parietes and tied, and the wound is closed without drainage of any kind.

Edebohls delivers the kidney and its fatty capsule on the loin, and removes the entire perirenal envelope down to the fibrous capsule. This capsule is then incised in the middle of the convex aspect of the kidney, and a grooved director is pushed between the capsule and the cortex as far as the upper pole. The capsule is then slit upwards on the director, and afterwards downwards to the lower pole. On both sides of this incision the capsula propria is reflected half-way to the hilus and held with pressure forceps. Usually in movable kidney the delivery of the kidney is very easy, and the fibrous capsule is somewhat thickened and stronger than in normal circumstances. Four sutures, two on each side, are passed through the reflected capsule at the line where it touches the cortex, one towards the upper pole, the other two near the lower end of the kidney. The kidney substance is not included in any of the stitches. The free ends of the posterior sutures are now passed through the posterior lip of the lumbar incision, and the anterior free ends through the anterior edge of the renal capsule. The muscular layers are then united by interrupted sutures, and when these have been fixed, the free ends of the sutures through the capsule are tied so that the exposed cortex of the kidney is brought in contact with the anterior surface of the quadratus lumborum. The skin wound is now closed with a continuous suture.

The method just described aims at inducing immediate union between the surfaces of the kidney and the parietes. While in most instances a good result has been obtained, union by granulation is the proper object we should have in view in the majority of cases. Undoubtedly healing by granulation is a slower process than healing by immediate union, but the ultimate result justifies the sacrifice of a little more time in bed. The length of time a patient should be kept in bed after nephropexy has been variously stated by different surgeons. It is always safe to allow the patient out of bed during the fourth or the fifth week. No doubt in many instances an earlier date might be fixed; but a few days longer in bed is not a great tax, while it secures more complete union between the kidney and its surroundings. There is nothing special otherwise in the after-treatment.

Results. Much misunderstanding exists regarding the value of operating upon movable kidney, and this has arisen from the circumstance that the cases have not been properly selected. Well-marked instances have been recorded where nephropexy has been performed, the mobility of the kidney being but a small part of the illness.

The writer's operative mortality is just under 1%, and the immediate results are most satisfactory. The remote results are more difficult to judge of, as many patients fail to report their condition even when asked to do so. 'In estimating them, it must be remembered that many patients whose symptoms were, in fact, referable to a general neurasthenia and not to the renal mobility have improperly been subjected to the operation. This contingent supplies the larger proportion of operative failures that are credited to nephropexy by those who see the patients subsequently.

'If judged by the results of the cases in which the symptoms have been *correctly* ascribed to the abnormal mobility of the organ, the percentage of failures attending the operation is very small, probably not more than 3 per cent.'[1]

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[1] Watson and Cunningham, vol. ii, p. 346.

CHAPTER IV

INTERNAL EXPLORATION OF THE KIDNEY: NEPHROSTOMY: NEPHROTRESIS

EXPLORATORY INCISION OF THE KIDNEY

Indications. Incision of the kidney is employed for exploratory purposes, for the removal of calculi or tumours, for the relief of tension or hæmaturia, for evacuation of urine or pus, and for drainage.

A disease in which operation is contra-indicated is cystic degeneration. Doubtless in this disease both nephrectomy and nephrotomy have been performed, but in almost all instances they have been resorted to under a mistaken idea of the nature of the case, many of the early operators having mistaken cystic degeneration of the kidney for ovarian disease. As cystic degeneration is usually bilateral and is associated with chronic interstitial nephritis, it is not a condition calling for nephrectomy, nor, seeing that the cysts are multilocular and widely distributed throughout the organ, is the patient likely to be benefited by nephrotomy; even an exploratory incision should be avoided. Any operative interference in these cases may lead to a fatal result.

Operation. The early stages of the operation are identical with those already described for exposure of the kidney (see p. 549). The kidney should always be drawn through the wound on to the surface of the loin, if possible.

When the symptoms are due to active or passive hyperæmia of the kidney, simple incision of the cortex and partial separation of the capsule may be all that is required to relieve the tension. As soon as the capsule has been divided, the borders of the incision separate, and the soft highly congested parenchyma pouts, the renal substance tending to form a hernia, proving the tension of the parenchyma within the capsule. After decapsulation and incision the tissue soon becomes relieved of the congestion, abundant escape of dark blood following the incision. The incision should be made along the convex border for 3½ inches, dividing the parenchyma ½ inch deep, not deep enough to open the pelvis.

The fibrous capsule is peeled off so as to expose the raw surface of the cortex, the cut edges of the capsule are sutured to the parietes, and the wound is allowed to heal by first intention, no drainage or packing being employed.

When it is necessary to open the pelvis, clear the constituents of the pedicle, find the ureter first, and then the vessels, and free them by wiping with dry gauze. Bleeding may then be easily controlled by an assistant compressing with his forefinger and thumb, or by applying clamp forceps covered with rubber tubing (Fig. 293), just firmly enough to press gently upon the vessels. It is difficult to pass a knife from the cortex to the pelvis of the kidney unless the cavity is well distended. This may be done by injecting fluid with a hypodermic syringe into the pelvis after compressing the ureter.

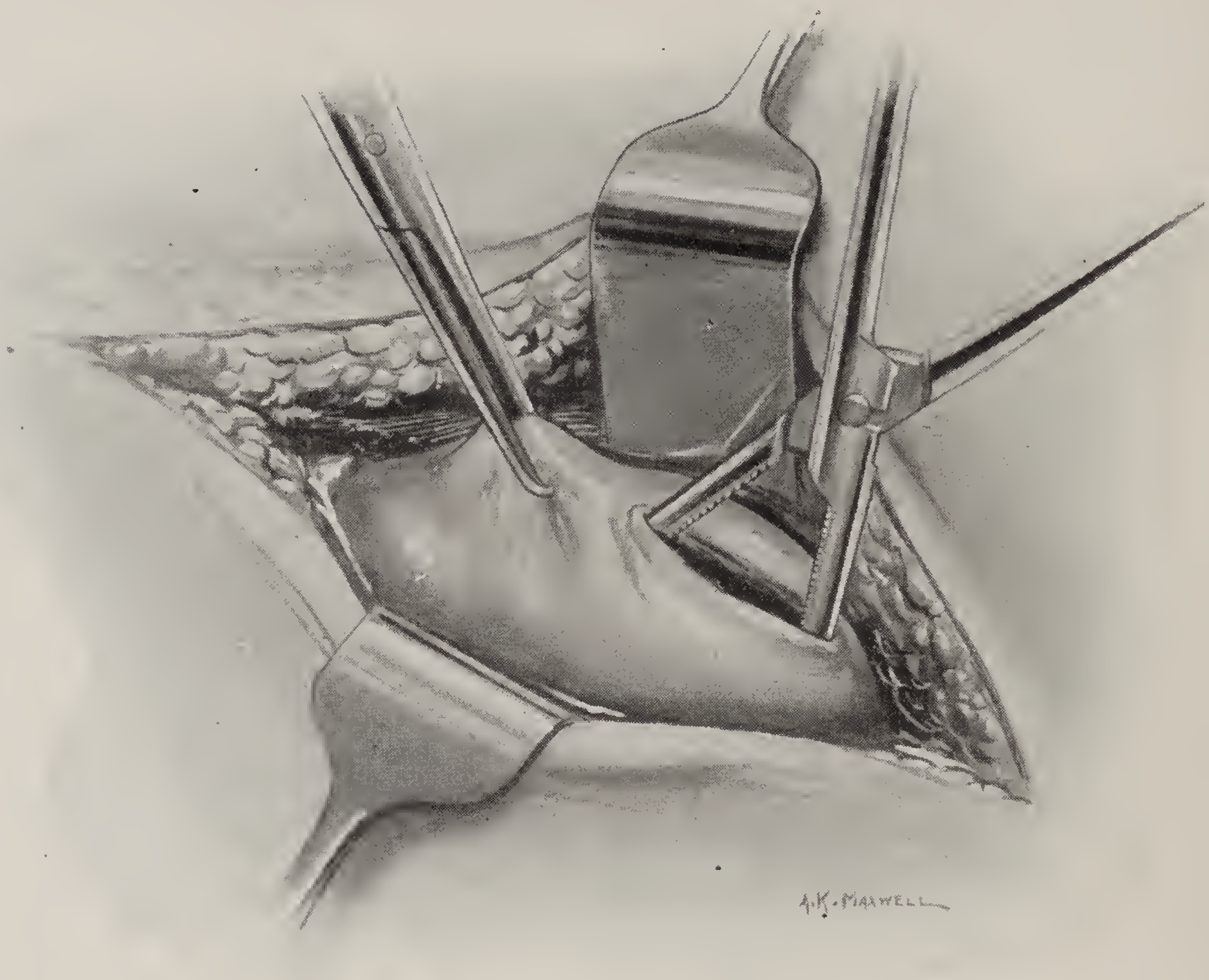

FIG. 279. DILATING THE OPENING IN THE RENAL SAC WITH DRESSING FORCEPS.

The blood-supply being controlled, and the pelvis distended, the kidney is grasped by its upper pole and an incision is made one-third of an inch posterior to the middle line of the convex border of the kidney. A pointed knife should be passed first into the lower calyces, and sinus forceps may be used to stretch the wound in order to make an exploration (Fig. 279), but if it is found necessary to enlarge the incision, a blunt, curved, probe-pointed bistoury (Fig. 281) should be introduced, and the pelvis opened along the line as far as may be required. The incision should be made from within outwards, and the bistoury being blunt, the arteries are pushed aside rather than cut through, and the incision being in the line of least vascularity, when pressure is removed from the renal pedicle little or no blood is lost.

When the morbid condition is associated with retention of fluid, fluctuation is easily made out, and palpation reveals one or two points where thinning of the cortex has taken place. The substance of the kidney is grasped with clamp forceps (Fig. 279), and a small incision is made into the cavity, which is enlarged by stretching the wound with dressing forceps until it is sufficiently large to admit the forefinger and to enable the surgeon to explore the cavity and parenchyma of the kidney.

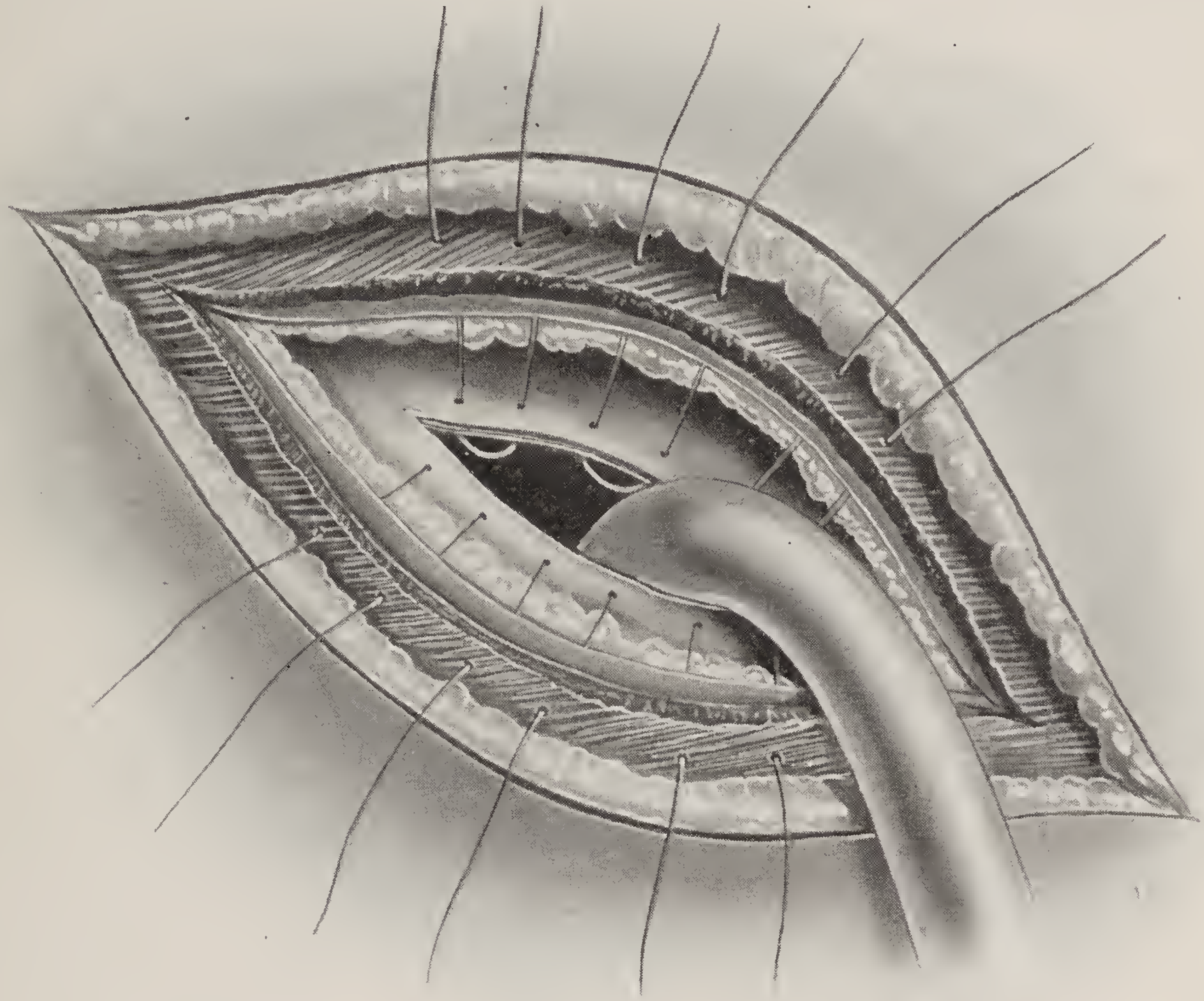

Fig. 280. The Method of suturing the Sac to the Parietes.

Should the lesion prove to be a hydronephrosis, a non-tuberculous pyonephrosis, or hyatid cyst, it is advisable not only to open the sac, but also to stitch its cut edges to the lips of the wound in the parietes, in order to reduce the danger of the surrounding tissues becoming infiltrated by urine or the contents of the sac. Two lines of sutures should be applied, one deep, the other superficial, and the parts should be adjusted as accurately as possible. The sac and the wound having been thoroughly washed out with a strong antiseptic solution, a large-sized drainage tube should be introduced at the most dependent part of

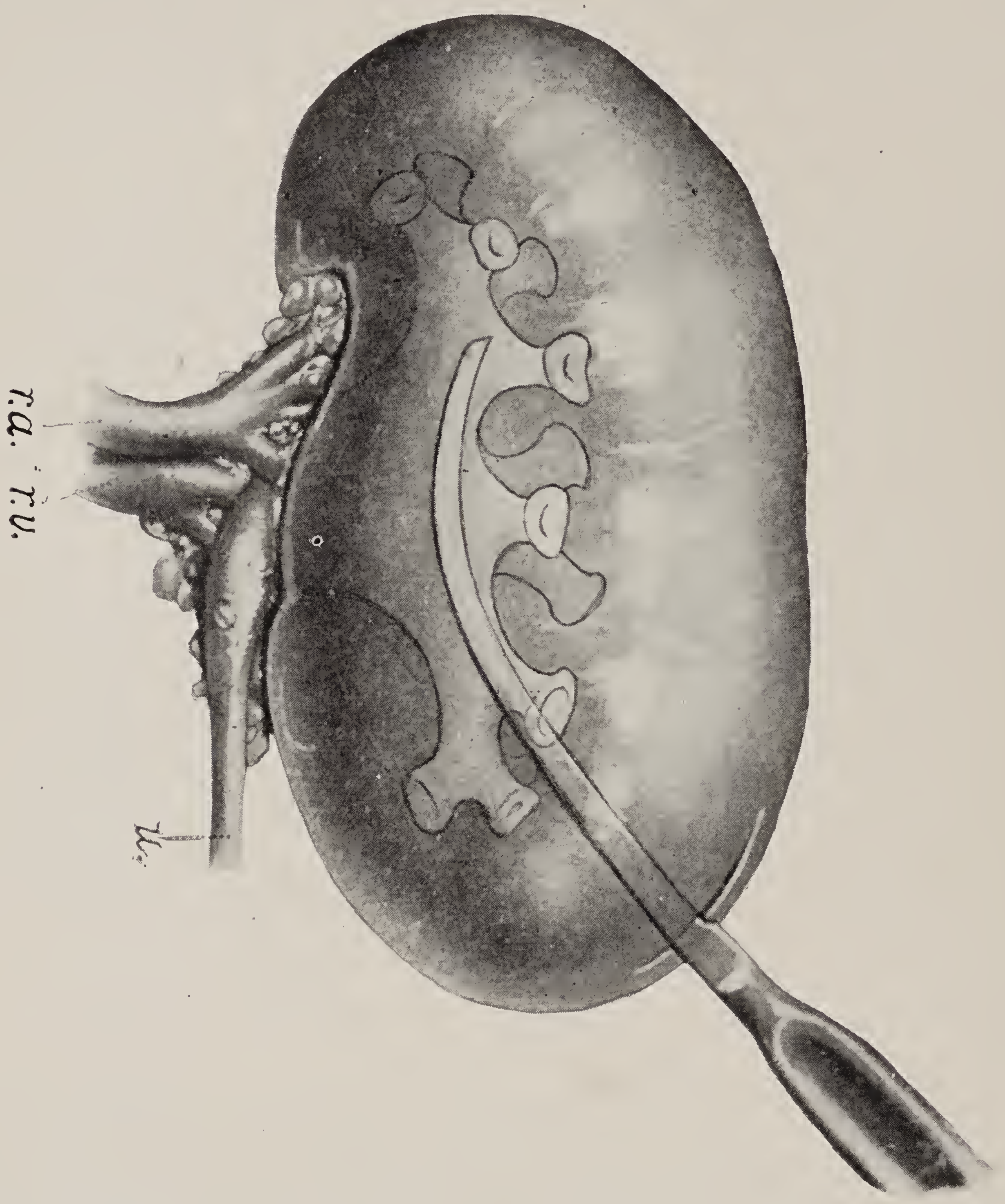

Fig. 281. Method of Opening the Pelvis of the Kidney in Nephrolithotomy. *r.a*, Renal artery; *r.v*, Renal vein; *u*, Ureter. (Newman, *Brit. Journ. of Surg.*, vol. i, No. 1.)

the wound (Fig. 280). The length of time that the tube must be retained depends upon the individual case.

The kidney and ureter should be carefully explored and the cause of the fluid accumulation determined, so that a complete operation may be performed at a later date, if the patient's condition does not justify effective measures being at once employed.

The operations required will be described below (pp. 587, 593), but it may be here stated that only when the indications for nephrectomy are very clear should the kidney be sacrificed, as often unexpected results are obtained from free drainage.

Resection of the sac, fixation of a movable kidney, the removal of a stone in the pelvis or the ureter, or a plastic operation upon the ureter may be required to effect a cure.

Therefore the following questions require consideration:

1. What is the general condition of the patient?
2. Is the lesion one that can be remedied or removed by nephrotomy?
3. If so, should it be dealt with at the time, or by a subsequent operation?
4. Is the kidney so destroyed that it is functionally useless, and only a source of trouble and danger to the patient; and, if so, is it safer to excise the kidney now or at a later date?
5. Is the lesion one which from its nature is inconsistent with life if allowed to remain, and should the disease be removed at once?

The general condition of the patient should be first considered. If there be tuberculous or septic infection of the pelvis associated with serious constitutional disturbance as a consequence of long suppuration, it is well to wait, and in the meantime to be satisfied with free drainage. But if the general health be good, the further steps of the operation will depend upon the local condition. The obstruction, if it be kinking of the ureter in movable kidney, may be rectified by nephropexy; if caused by an impacted stone, by its removal the natural passage will be free; if as a consequence of stricture of the ureter, ureterotomy or a plastic operation may remedy matters; but if the obstruction cannot be removed, then the surgeon should satisfy himself by establishing a drain in the loin and a subsequent nephrectomy be left for further consideration. This rule should apply both in cases of hydronephrosis and pyonephrosis. To remove the kidney when the sac is large, and the patient is still suffering from the effects of an acute, often a critical illness, is a mistake. The danger to life is considerable and the healthy kidney may fail to respond to the additional work placed upon it.

If the pedicle is not compressed when the cortex is cut into, occasionally sharp but not prolonged hæmorrhage occurs, but can usually be easily controlled by pressure, or by retaining the finger in the wound for a few minutes. By making the incision in the line indicated above, few arteries of any size are divided, and the smaller arterioles, which bleed profusely at first, soon contract and become closed.

Difficulties. When the kidney is not greatly altered in appearance, the operation of nephrotomy is easily performed, but in not a few instances the structural changes in and around the organ are so great that it is with the utmost difficulty that the surgeon can assure himself of the relationship of parts. This arises from induration and hypertrophy of the adipose capsule, which becomes tough and inseparably from the kidney, or the organ may be distorted or shrunken, or its contents may have escaped into the perinephric tissues. Under such circumstances the incision must be made at the most prominent point.

The dressings and after-treatment will be considered in the following chapter (see p. 571).

NEPHROSTOMY AND NEPHROTRESIS

Nephrostomy means incision into the pelvis of the kidney and stitching the lips of the renal wound to the parietes, followed by drainage, which may be temporary or permanent.

Nephrotresis is the term employed for long-continued or permanent drainage of the kidney arising from an obstruction in the ureter which cannot be remedied, or when there is disease of the bladder, such as a malignant tumour, which demands total cystectomy.

These two operations may be considered together.

Indications. (i) The most urgent condition demanding this operation is obstruction to the excretion of urine, and in considering the question of operation a clear distinction must be drawn between true and false anuria. The former (*secretory anuria*) includes cases in which the function of the organ is entirely suppressed, as in diffuse nephritis under toxic influences and infectious diseases, in tumours of the kidney, disease of one kidney and absence of the other, and in reflex anuria. The latter (*excretory anuria*) is caused by obstruction to both ureters or obstruction to one ureter, while the secreting power of the other kidney is impaired. Whatever the cause of obstruction may be, it must either be removed at once or nephrotresis must be performed. In cases of unilateral obstructive anuria as well as in bilateral, if the surgeon be in doubt as to the capacity of the kidney first operated upon to sustain life, both should be opened. Reflex suppression in an unobstructed kidney is more common than is generally supposed (see *Report of International Association of Urology,* Paris, 1908). In secretory anuria incision and relief of tension often restore the function as a consequence of the blood-letting and by permitting passage of the urine from the uriniferous tubules.

(ii) When a ureter is obstructed by a condition which cannot be removed. As soon as this is proved, the pelvis of the kidney should be opened and drained in order to save the kidney from the destruction which is otherwise certain to follow.

(iii) In cases where the ureter has been injured and the function of the duct cannot be restored by grafting the ends together.

Operation. The operation is the same as exploration and nephrotomy (see p. 549), only the drainage tube is kept in and the urine is collected as it forms.

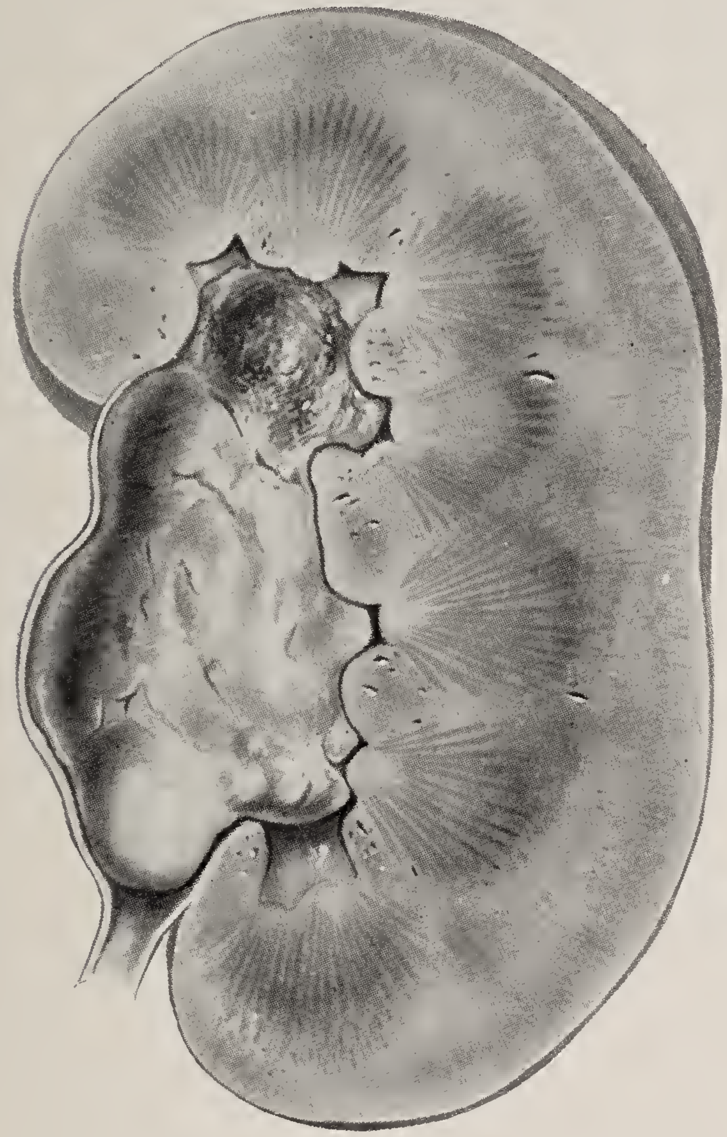

Fig. 282. A Calculus moulded and fixed, causing no Pain or Hæmaturia, only Pyuria.

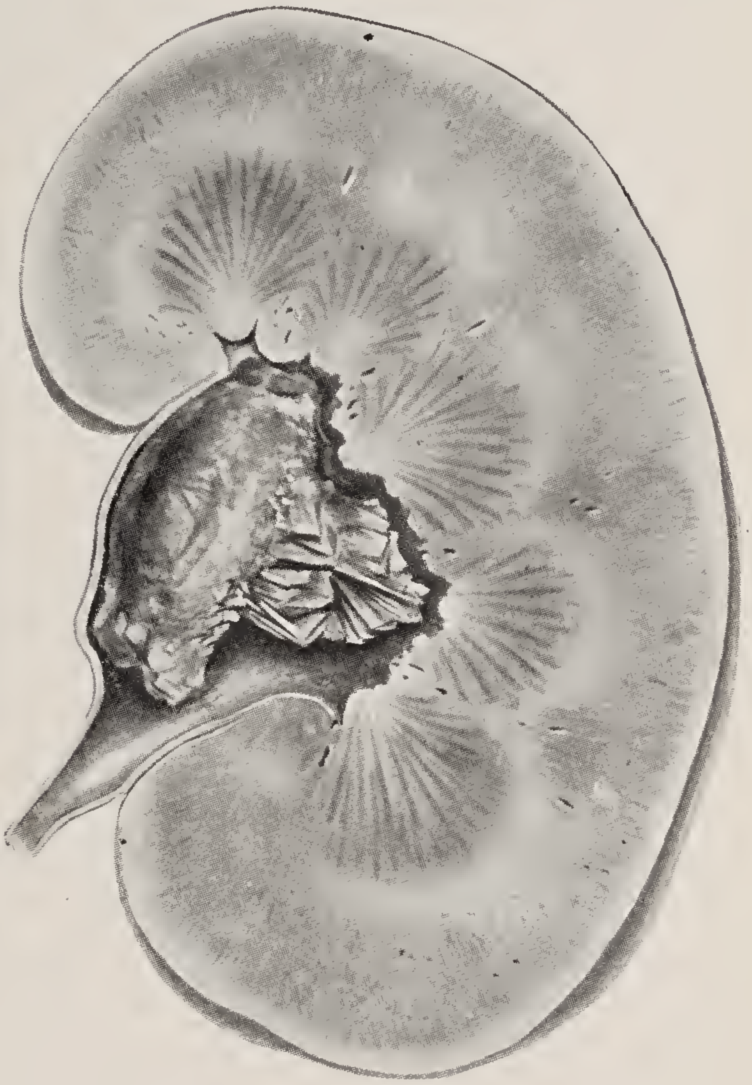

Fig. 283. A Large sharp Stone in the Pelvis of the Kidney, causing severe Pain and profuse Hæmaturia. (See *Lancet,* 1909, vol. i, p. 8.)

In cases in which it is necessary to drain the kidney or bladder for a considerable period, it is a great comfort to the patient to be able to move about unhampered by bulky and often soaked dressings. Direct drainage by siphoning the urine into a suitable vessel permits the patient to go about with freedom. The skin and clothing are kept dry, and considerable expense is saved. The method the writer used for the last five years has been found most useful, both in draining the bladder after suprapubic cystotomy and the kidney in cases such as old-standing hydronephrosis and pyonephrosis; a description of it will be found in the *Glasgow Medical Journal* for September, 1907.

The rest afforded by a lumbar drain allows time for compensating hypertrophy of the opposite kidney to take place, and not infrequently permits of gradual absorption of inflammatory products, so that a ureter which has been more or less obstructed for a long period may again become patent. This may be demonstrated by injecting coloured fluid into the fistula, and if it appears in the urine escaping from the bladder, then the question of closing the wound in the loin may be considered. If, however, the constriction remains permanent, the subsequent proceedings depend upon the relative amount of work done by the diseased kidney and its neighbour, which may be ascertained, not by measuring the quantities of fluid coming from the wound and from the bladder, but by estimating the amount of urea excreted by each organ; a kidney which is almost useless functionally may excrete more fluid than its healthy neighbour, but the excretion may be little more than water mixed with a little pus.

CHAPTER V

NEPHRO-LITHOTOMY: OPERATIONS UPON THE RENAL PELVIS

Indications. In many cases a stone may be known to occupy the kidney, but may cause the patient little trouble. This depends upon the character of the calculus, and whether it is fixed in its position, or by its mobility causes obstruction to the escape of urine, or from its irregular surface irritates the mucous membrane of the pelvis (Figs. 282 and 283). This operation may be demanded under two very different circumstances—firstly, when the foreign body has, by its presence, induced suppuration in the kidney or its pelvis; and, secondly, when, by the recent improvements in diagnosis, the surgeon is able to detect the presence of a stone before pus accumulates in the kidney or appears in the urine.

The operation may be performed either by the lumbar or the abdominal route.

LUMBAR NEPHRO-LITHOTOMY

Operation. The early stages of the operation are similar to those of exposure of the kidney (see p. 549). The later stages vary according as sepsis is present in, or absent from, the pelvis of the kidney.

When there is no septic pyelitis. In cases of calculus unassociated with distension of the pelvis or enlargement of the organ some difficulty may be experienced in discovering the position of the stone, especially if it be small in size and embedded in the substance of the kidney. When the kidney has been delivered on the loin and held with one hand, the first duty of the surgeon is to examine it carefully and systematically by palpation with the fingers of the other hand, and should any part of the kidney or pelvis offer undue resistance such as to suggest the locality of the calculus, this evidence must be further tested by puncturing the organ with a fine-pointed bistoury. This method of exploration must be carried through systematically and freely, there being reason to believe that the renal parenchyma suffers little from this mode of examination. The substance of the kidney having been carefully searched and no calculus found, the pelvis should next be punctured, and a curved probe or director should be passed and the entire cavity of the kidney explored.

If a calculus be detected by the hand or the probe, the operator has the choice of incising the renal parenchyma or the wall of the pelvis. If the calculus be lying close to the capsule of the kidney it is clear that the easiest and safest method of reaching the stone is by cutting through the tissue covering it, and this should be done by a straight incision with a narrow knife to begin with; the opening may be enlarged by dilating with dressing forceps, by which the stone may be seized and extracted. When, however, the stone is situated in the pelvis or one of the calyces, the question arises, Should the wall of the pelvis or the renal tissue be incised? In respect to this point there is a difference of opinion. Stones of large size have been removed by incision into the pelvis, while calculi of equal size and weight have been extracted by dividing the renal tissue by the knife. The bulk of the stone cannot therefore be taken as a guide. While the two methods are equally satisfactory in respect to the immediate result, the wound has healed more easily in those cases in which the incision has been made through the parenchyma, and permanent urinary fistulæ have been less frequent.

After the stone has been removed, the kidney should be packed with a narrow strip of iodoform gauze, or a drainage tube should be left in. It is well not to suture the kidney, as free drainage for a few days after the operation is of the first importance, but the parietal wound, muscles, fascia, and skin must be carefully brought together, an opening being left for drainage only.

When there is septic pyelitis. Prior to opening a calculous hydronephrosis or pyonephrosis it is well to empty the sac by aspiration and wash it out thoroughly with an antiseptic solution. When the sac is emptied the kidney is more easily delivered, and it is especially necessary to reduce the bulk of the organ when the ileo-costal space is small. It is a great advantage in determining what operation should be done to have a good view of the entire organ. When the sac of the pyonephrosis is opened, a systematic method should be employed to explore the cavity of the kidney for a calculus, and for this purpose the organ should be delivered on to the surface of the loin when possible, and the pelvis and calyces, as well as the parenchyma, carefully examined with the fingers, which are more reliable than any other instrument in discovering a stone.

In the great majority of instances the calculus is found without trouble, but when the cavity is very large the fingers may fail to reach the deeper parts, and this is especially the case when the stone is embedded in the upper part of the ureter. In such instances it is well to drain the kidney for a few weeks and to make another search when the pyonephrosis has contracted.

The stone having been discovered with the finger, an attempt should be made to remove it through the incision already made in the parenchyma, either by the finger, a small lithotomy scoop, or forceps (see Fig. 303). Should, however, the stone be firmly fixed in the calyces, the best plan to adopt is to press the stone firmly towards the point where the cortex is thinnest with the finger in the cavity of the pelvis, and to remove the calculus entire through a fresh incision made there. This should be done, even if it demand a very free incision in the cortex, rather than break the stone, as fragments are liable to be left behind and form centres for future concretions.

Phosphatic stones, with bacillus coli infection of the renal pelvis, are often so friable that they crumble in fragments as soon as they are grasped with forceps. In such circumstances the concretion must be removed with a spoon and the whole interior of the sac scraped carefully and drained for a considerable time. When the urine is alkaline the cavity in the kidney should be washed out twice daily, and after free irrigation a fluid culture of pure lactic acid bacilli should be introduced through the drainage tube and left in. By setting up lactic acid fermentation the urea-decomposing organisms are weakened or destroyed, and the acid formed dissolves the phosphates. Whether the lactic acid bacilli have the power of destroying the pathogenic organisms or not it is difficult to say, but certainly they reduce their activity and virulence.

After a stone has been removed from the pelvis of the kidney, or from the substance of the organ, a careful examination must be made to see that no other concretions exist in either of these situations or in the ureter (see p. 599). Under exceptional circumstances, when the calculus is branched and is firmly adherent, it may be necessary to divide it into two or more parts and remove each fragment separately. This is best done with small bone-cutting forceps. If no stone be found after free incision and thorough exploration, the ureter must be examined throughout its length (see p. 600).

Difficulties. Besides those mentioned under nephrotomy, the presence of a stone in the kidney presents difficulties peculiar to that disease. (1) The stone may be so small that it is very difficult to locate it in a calyx, or in the pelvis (see Fig. 284), or it may occupy an independent pouch and only drop into the pelvis occasionally. (2) The calculus may be branched and firmly adherent to the calyces or pelvis. (3) Very large stones are often difficult to remove, or considerable trouble may be required to remove all the calculi present because of their large number. (4) The stone of phosphatic origin may break up very easily, and consequently can only be removed in fragments.

(5) A calculus of considerable size may exist in the kidney without being detected, even by a most careful and skilled examination.

Dangers. *Hæmorrhage.* While the loss of blood at the operation may be considerable, it is not often a serious danger except in patients whose strength is greatly reduced, and any considerable loss of blood following the operation is rare. The cases in which bleeding is most difficult to control are those in which we have to deal with tissues which are indurated, and when the arterioles are converted into rigid tubes which do not contract or retract when divided. In such cases it is safer to excise the kidney. If the bleeding cannot be controlled at the operation by douching with hot water, plugging with gauze, and applying pressure to the surface of the kidney, adrenalin may be employed locally. Should these methods not succeed it will be necessary to remove the kidney.

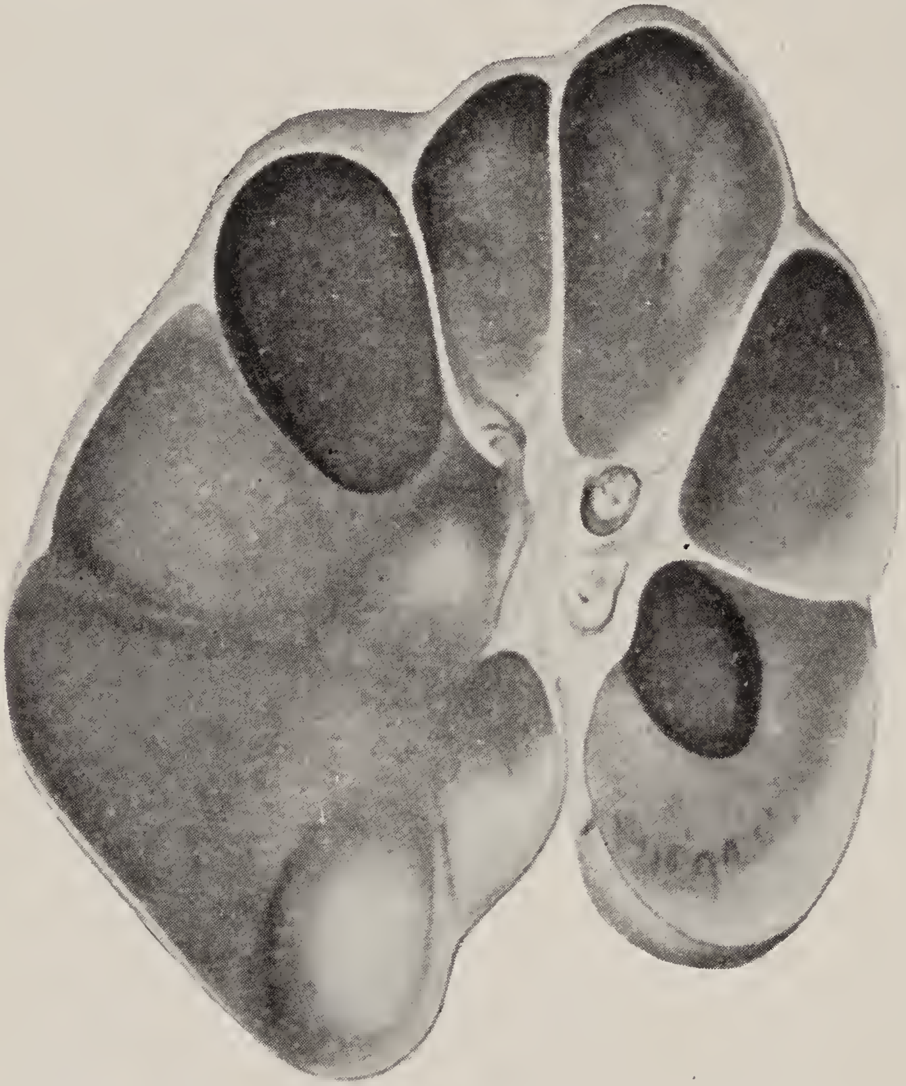

Fig. 284. A Small Stone, causing Complete Destruction of the Kidney and Very Large Hydronephrosis.

Shock. In old-standing disease shock is often very marked for the first eighteen or twenty-four hours, and sickness may be persistent. This should be guarded against by having the patient under observation and treatment for some time prior to the operation, so as to get him into as favourable a condition as possible. Also the surgeon should be specially careful to operate as rapidly as possible, and not to do more than is absolutely necessary at the time. Loss of body heat may be avoided by wrapping the limbs and as much of the trunk as possible in warmed gamgee tissue, and, if necessary, strychnine and saline injections may be administered.

Septic infection. This is only likely to happen when the surgeon fails to provide free drainage. If the drain be kept in till the surfaces of the wound have had time to granulate, the pyonephrosis is not likely to cause any general infection.

Uræmia. This is only likely to occur when the other kidney is also diseased, but, with our present methods of examination, this emergency should be foreseen and guarded against.

After-treatment. The patient should be placed in bed in the recumbent posture with a soft pillow under the shoulder and hip on the affected side so as to avoid pressure on the wound. The dressings should be changed at frequent intervals if any blood or urine soaks through.

The packing or drainage tube may be removed or shortened on the fourth or fifth day in a non-suppurative case, but when sepsis exists prior to the operation, a tube should be retained as long as a purulent discharge continues. In such cases the wound should be douched with 1 in 40 carbolic acid solution.

When there is much shock after the operation, the foot of the bed should be raised on blocks, hot bags applied, and rectal feeding employed until nourishment can be taken by the mouth. Warm barley-water, flavoured with lemon, and warm soured milk are most easily retained, and are very grateful to the patient, and while they act as diuretics they also prevent flatulence, which is often so troublesome after renal operations.

When suppression of urine occurs, normal saline injections into the rectum or into the subcutaneous tissue are indicated, or subcutaneous injections of pilocarpin may be administered.

Retention of urine after renal operations is very common and requires the passage of a catheter. In men, the reflex congestion of the mucous membrane of the urethra and the muscular spasm are sometimes so great that a catheter will not pass—even the gentle introduction of an instrument may cause free bleeding. Rather than persevere with the catheter, it is advisable to apply hot fomentations to the perineal and hypogastric regions, and to introduce a half-grain or a grain morphia suppository.

Results. The causes of death in nephro-lithotomy depend not upon the operation but upon the stage of the disease for which it is performed. Eliminating all cases in which the presence of a calculus was associated with sepsis, nephro-lithotomy may be described as almost free from danger, the mortality being only 1.8%, whereas when sepsis has been established a very different result (8.7%) is obtained.

ABDOMINAL NEPHRO-LITHOTOMY

Abdominal nephro-lithotomy was suggested by Mr. Knowsley Thornton, who recommended an abdominal incision for the purpose of exploration, and, if a stone be found, a second incision in the loin for its extraction.

When first introduced this operation was employed occasionally, but time and experience have limited its use to exceptional cases.

OPERATIONS UPON THE RENAL PELVIS

Papillotomy. In cases of renal varix, small tumours in the pelvis of the kidney, or bleeding ulcers, after bisection of the kidney it may be found necessary to remove a papilla or a portion of the kidney from the side of the pelvis.

Pyelotomy has been suggested in place of section of the cortex, and has been successfully carried out in a few fortunate instances, but great is the danger of overlooking a small lesion in the pelvis when the latter is opened direct. The kidney is divided in its whole length as described above (p. 561), the pelvis is fully exposed to view, the lesion in the kidney is located and removed by cutting out a wedge-shaped section, and the cut surfaces of the papillary wound are sutured with fine catgut. The surfaces of the longitudinal incision are then carefully adjusted and fixed by thick gut mattress sutures for the parenchyma, and fine interrupted sutures for the margins and capsule (Fig. 285).

Curetting. In cases of tuberculosis of the renal pelvis, renal varix, and tumours of the kidney, curetting of the pelvis or of one or two of the calyces of the kidney has been resorted to, but seldom with ultimate success. If the lesion is one that can be completely removed, papillotomy is the operation to be recommended, whereas if it cannot be excised by clean cutting the free use of the curette is not likely to do good.

Excision of tumours. The cases of successful excision of tumours from the pelvis of the kidney are very few in number, for the reason that in the pelvis of the kidney, as in the posterior nares and the rectum, papillomata, which appear histologically to be benign, nearly always prove clinically to be malignant: consequently the proper treatment is total nephrectomy combined with ureterectomy. It is advisable to remove the ureter because of the well-known tendency of such tumours of the kidney to recur in the ureter, and the danger of recurrence persists for years after a nephrectomy. The only growths successfully removed from the pelvis are simple angiomata. Papillomata, even in children, are generally malignant.

Pyelotomy is the term employed for the operation of opening the renal pelvis sufficiently to explore its cavity with the forefinger, and has been used to avoid the procedure of opening through the parenchyma of the kidney. It is used now in aseptic cases in which a stone is known to be located in the pelvis, or for sounding the ureters from above downwards.

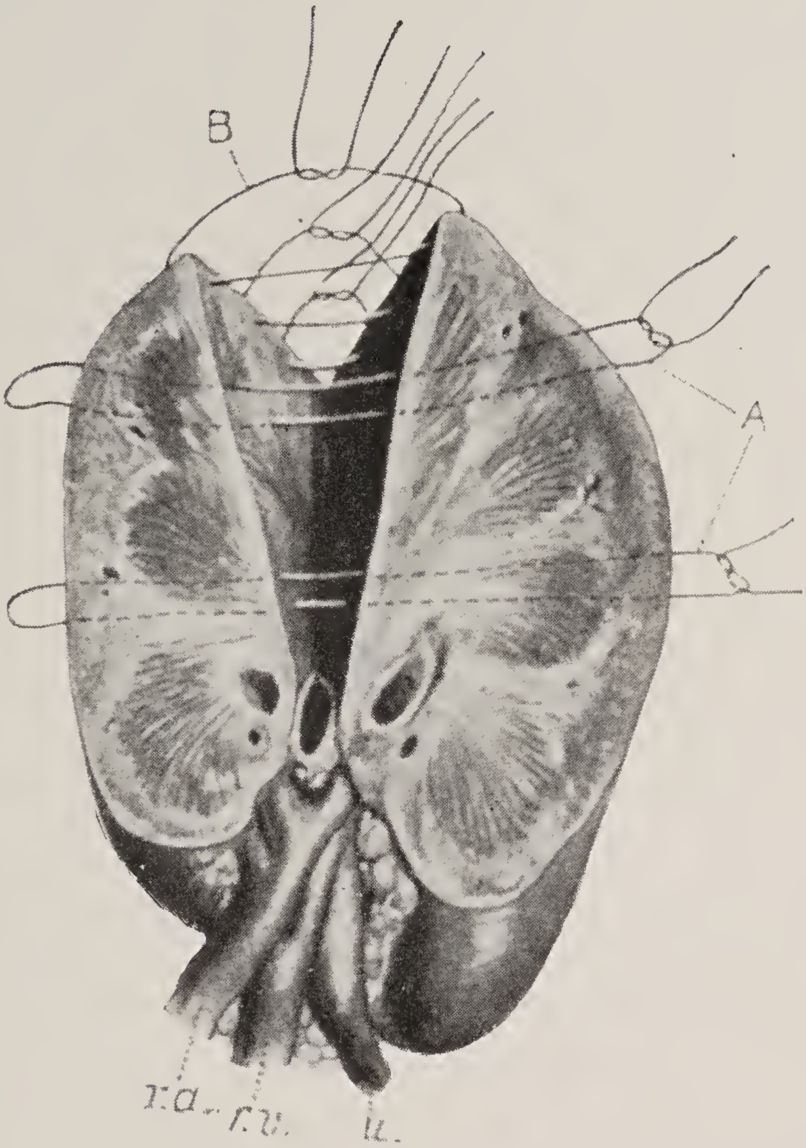

Fig. 285. Section of a Kidney, showing the Mode of Suturing. a, Mattress sutures passed through the substance and capsule of the kidney. b, Interrupted sutures uniting the capsule and superficial parts. *r.a*, Renal artery; *r.v*, Renal vein; *u*, Ureter. (Newman, *Brit. Journ. of Surg.*, vol. i, No. 1.)

After the kidney has been freed from its surroundings and delivered on to the loin, it is pushed upwards over the upper lip of the wound. Then a clamp with rubber tubing covering the blades is gently applied to the vessels of the pedicle, leaving the ureter free.

The kidney is held fixed by an assistant and an incision is made from the junction of the pelvis with the kidney downwards towards the ureter, care being taken not to cut too deeply so as to wound the other side of the pelvis. The incision must be sufficiently long to admit the tip of the little finger, but if this cannot make a satisfactory exploration, the incision must be prolonged to admit the forefinger. It is much better to enlarge the opening by a clean cut with the knife than to tear by dilating. As a rule the little finger succeeds in making a complete exploration. After a general examination of the pelvis, each of the calyces should be explored separately, even although a stone has been already found, as frequently there is more than one. This rule applies to all examinations. Be not contented by finding a lesion which may explain the case, satisfy yourself that there are no others; full exploration probably involves only a few minutes' delay.

A small stone is usually easily dislodged by the finger, a small spoon, or curved dressing forceps. For the removal of a large stone this operation is not suitable, nor does it give a satisfactory view of the cavity of the kidney. When the operation is limited to suitable cases the risk of urinary fistula following is very small. The incision should be closed completely by Lembert sutures and a drainage tube left in the wound of the parietes. If the ureter is free, no escape of urine should take place from the pelvis, but if the ureter is not, it is well to place a drainage tube into the pelvis.

Suturing of incisions in the kidney is employed to control immediate hæmorrhage and to secure satisfactory union. On account of the friable nature of the parenchyma stout catgut is used. The round wide-curved needle is employed and the sutures are laced mattress-fashion about one-third of an inch apart (Fig. 285) through the substance of the organ, while interrupted sutures are used to unite the capsule and superficial parts.

It is necessary to pass the sutures A through the capsule of the kidney, otherwise they are liable to cut into the substance of the kidney and become loose.

After the sutures have been applied, the kidney is replaced in its normal position, and the wound in the parietes thoroughly washed out with boric acid solution. A cigarette drain is then introduced and kept in as long as there is any urinary leakage. The muscular structures are brought together in separate layers with gut sutures while the skin is sewed up with silk, a continuous button-hole stitch being probably the best.

NEPHRO-LITHOTOMY (MAYO TECHNIQUE)

Mayo has reported in *Surgery, Gynæcology and Obstetrics* his technique and the results of the operation at the Mayo Clinic. The experience of this master surgeon is such that I thought it advisable to insert his report, which is as follows:

From January 1, 1898, to December 31, 1915, 450 patients with stone in the kidney were operated on in the Clinic (484 operations). Three died, a mortality of 0.6%. The percentage represents the number of patients who died in the hospital without regard to cause of death or length of time after operation. The results achieved were due more to the painstaking care with which the diagnoses were made, the function of the kidney estimated, and the patients prepared for operation than to any purely technical feature of the procedures employed in removing the stones.

Recurrence. Multiple stones in the parenchyma of the kidney are prone to recur. In one case in which I removed 28 stones from one kidney and 26 from the other, I re-operated on the patient within two years for stones in both kidneys. Grave symptoms gradually developed each time the stones re-formed. It is possible that in the few cases of this type which have come under our observation, the stone formations were secondary to hæmatogenous infections of the cortex. Fortunately, multiple parenchymatous stones in both kidneys occur but rarely; according to Braasch they were found in but 5 of 48 cases of bilateral stones.

Persons having large and branched stones located in hopelessly damaged and infected kidneys are exceedingly liable to recurrence of stone following a conservative operation and therefore, if the remaining kidney is sound, there is an increasing tendency on the part of surgeons to remove the affected organ at the primary operation. Previous to the nephrectomy, urologic examination will have demonstrated the absence or the great reduction in functional capacity of the affected organ and will have shown that it is infected beyond permanent restoration to even limited function. In our experience one of the most common causes of recurrence of stone has been attempts to conserve a badly damaged kidney which was of little use functionally and a continuous menace to the future health of the patient.

If both kidneys are involved extensively, it will of course be necessary to save them both. After the removal of the stones under these circumstances, the pelvis of the kidney should be drained by a rubber tube through the cortex, and each calyx containing a stone, which has extended out into the parenchyma by atrophy necrosis until it can be felt with the finger as a softened area in the cortex, should also be drained separately through a counter-puncture. Drainage provides an opportunity for the relief of the infection and also for contraction of the large renal cavities from which the stones were removed. Drainage must be thorough and effected by means of a rubber tube and rubber tissue rather than gauze. Gauze drainage tends to leave a fistula which is slow to heal. Small cigarette drains, however, are satisfactory for the drainage of the calyces and smaller stone-containing pockets, but a tube should be used for drainage of the pelvis.

Recurrence of stone is sometimes due also to attempts to remove the stone through a too small incision. In these attempts the stone is crushed or fragments are loosened from it which remain in the urinary tract to be painfully passed out later by way of the ureter or to become the nidus of a secondary kidney stone.

Another error to which Braasch has called attention is the fact that, in cases of multiple stones, roentgenograms may show only a single shadow, because the several stones are superimposed upon each other. We, therefore, should not trust entirely to the roentgenogram as to the number of stones present. We must produce all the stones that are shown by the roentgenogram and then introduce the finger into the pelvis and cavities to see that no others remain. On one occasion after a stone corresponding in location, size, and general appearance to the finding in the roentgenogram was removed from the pelvis, a second roentgenogram made before the patient was discharged from the Clinic showed a small stone which had remained hidden. To prevent these failures, a roentgenogram of the kidney is now made in every case of operation for the removal of stone before the patient is discharged from the Clinic. It has been stated that we cannot know whether or not the stones have re-formed in a kidney unless a roentgenogram has been taken. Unfortunately, however, unless a roentgenogram is taken immediately after the operation, we have no means of knowing whether stone shadows in a subsequent roentgenogram are those of stones that were overlooked or of new ones.

Our experience shows that the percentage of recurrences of stone will be small, certainly under 10%, if at the primary operation good judgment is exercised in selecting and carrying out the best surgical procedure for each individual case.

SURGICAL TREATMENT

Hospital organization and operating-room technique have been so standardized that during an operation sepsis is rarely introduced from without. With good exposure the surgeon is able to properly handle septic renal conditions and prevent soiling of the operative field from within. Next to soiling from septic contents of the kidney itself, lack of proper hæmostasis is the most frequent cause of those processes which, directly or indirectly, lead to sepsis and death, or those secondary conditions which end in recurrence of stone, hernia, or other sequelæ.

The incision outlined in Fig. 286, and which I have described previously, mobilizes the lower wall of the thorax, enables adequate exposure of the kidney, and does not result in injury to important nerves or other structures. As pointed out by Charles H. Mayo more than fifteen years ago, a cross cut of muscle when properly sutured is almost never followed by hernia. On the contrary, the muscle fibres have little cohesion and are held together laterally by aponeurotic coverings on which structures the protection against hernia in muscle-splitting operations rests.

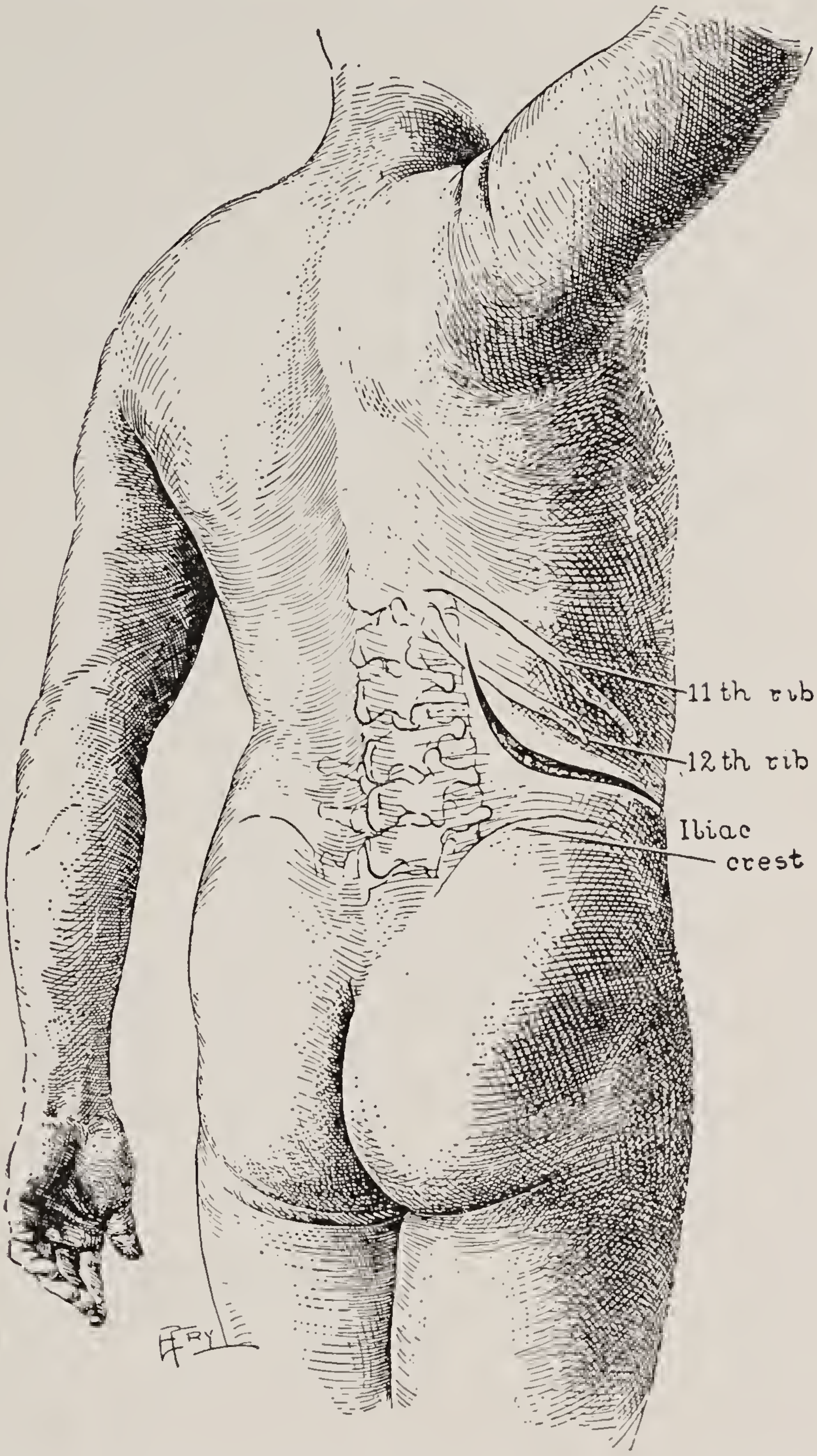

FIG. 286. PROPER INCISION FOR OPERATIONS ON THE KIDNEY. (*Mayo.*)

Pelvio-lithotomy (200 cases). Pelvio-lithotomy is the most generally useful operation for stone in the kidney. As shown by Brödel, the anterior row of calyces and the anterior half of the posterior row in about 95% of the cases are supplied by the anterior renal arteries and the kidney is notched on the posterior surface. In the small remainder the contrary is true. The kidney is separated from its fatty capsule and brought well up into the wound so as to expose the pelvis in the notch. If the stone is felt, it is removed by direct incision, and a search is made with the finger within the pelvis for others. The pelvis is then sutured with catgut, the kidney dropped back into position, carefully surrounded by its fatty covering (which should not have been lacerated in the separation), and two or three rolls of rubber tissue are introduced into the kidney space to provide temporary drainage. If the stone cannot be felt, needling or pummelling in an effort to confirm the X-ray diagnosis injures the kidney and serves no good purpose. The pelvis of the kidney should be exposed by dissecting the fatty tissues back from it in a flap-like manner, and the stone located by the finger introduced through an incision into the pelvic cavity, and removed. The capsule should then be sutured with a few interrupted sutures of catgut, and the fatty fascial flap, to which I have previously called attention, placed and sutured in position (Fig. 287). The kidney should then be dropped back within the fatty capsule and the rubber-tissue drains introduced. Drainage of the pelvis of the kidney is rarely required after pelvio-lithotomy for uncomplicated stones in the pelvis. If necessary, it should be done not through the pelvis, but by counter-puncture through one of the calyces, preferably the posterior inferior calyx.

Combined pelvio-lithotomy and nephro-lithotomy, 34 cases. While usually it is possible to remove stones situated in the calyces through the renal pelvis, the communication between the renal pelvis and the calyx may be so small as to cause fragmentation of the stone in attempts at removal. Moreover, much cortical infection may be present about the stone, necessitating drainage. With the finger in the pelvis, a counter-puncture permitting easy removal of the stone should be made in the cortex above it and a drain inserted. Stones may be removed in this way from several or all the calyces. Each cavity should be drained separately; at least one tube should lead to the renal pelvis.

Nephro-lithotomy (4 cases). Nephro-lithotomy is an operation we seldom perform for uncomplicated stones in the pelvis and calyces. It injures the kidney and is liable to be followed by secondary hæmorrhage by way of the ureter, beginning four to ten days after operation. The hæmorrhage may be so severe as to necessitate the removal of the kidney to check it. Several of our patients had hæmorrhages after operation, and in 4 it was necessary to do nephrectomy to save their lives. This, of course, is an extremely high percentage, and does not represent what might be called the normal incidence of secondary hæmorrhage, since the stones were removed from the kidney through the cortex, not as an operation of choice, but only for good and sufficient reasons. It was done, for instance, in secondary operations when the kidney was firmly fixed as a result of former operation.

The rule is that if a stone is removed from an infected kidney by nephro-lithotomy, a drain is introduced through the cut cortex of the kidney into the pelvis; otherwise drainage is unnecessary. If a number of stones are present and there is atrophy necrosis in various areas of the kidney-substance over the stones, it is wise to drain each cavity separately. Small cigarette drains are excellent for the purpose.

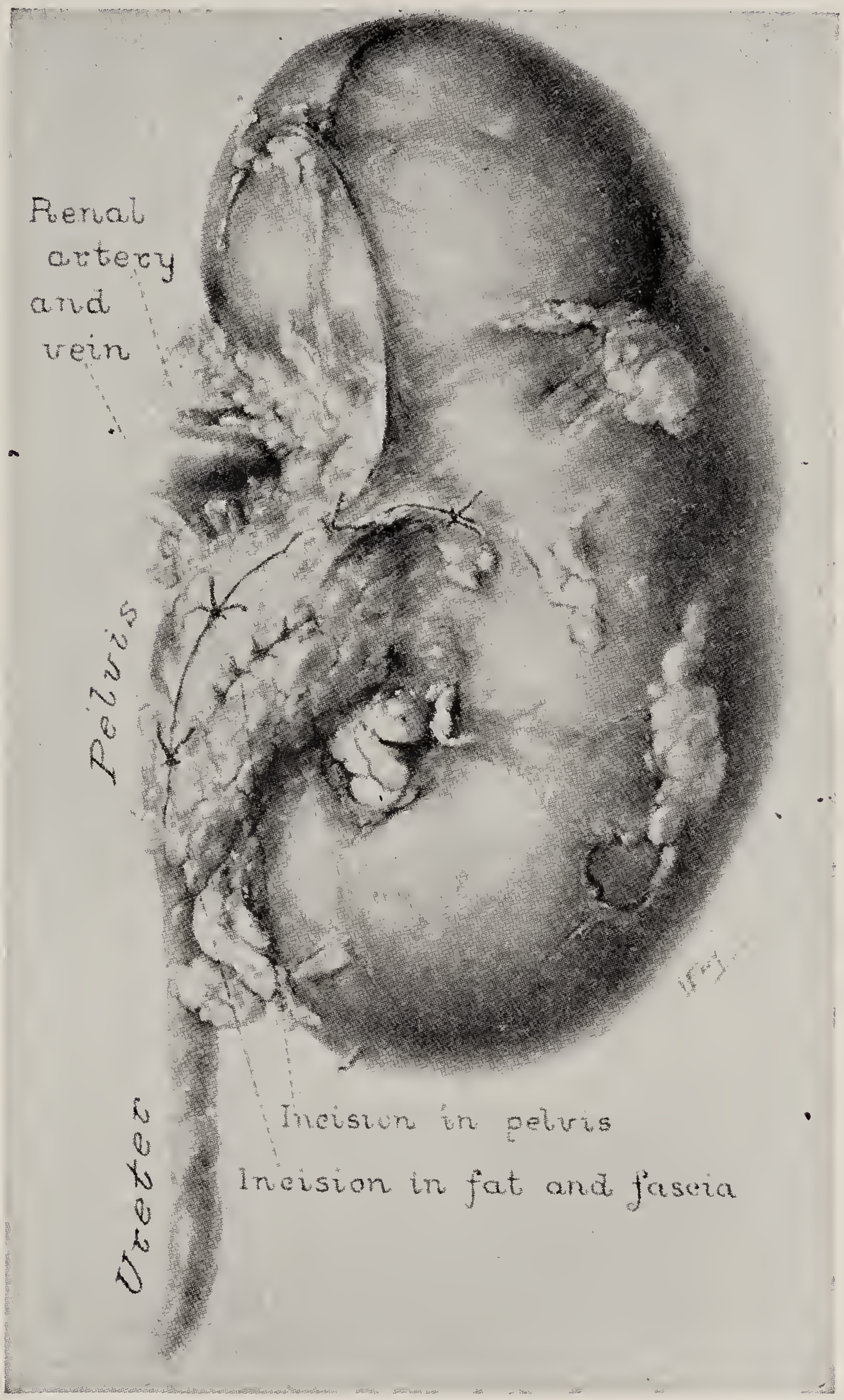

FIG. 287. PELVIS OF THE KIDNEY SUTURED, FATTY FASCIAL FLAP REPLACED, FOLLOWING PELVIO-LITHOTOMY. (*Mayo.*)

Nephrectomy (204 cases). In not a single instance in which nephrectomy was performed was there reason to regret the removal of the kidney either after examining the specimen or in the later events of the patient's history, while in a number of instances in which a conservative operation had been performed the necessity for secondary nephrectomy after some months or years of trouble made it evident that the excision of the kidney would have been the better primary operation.

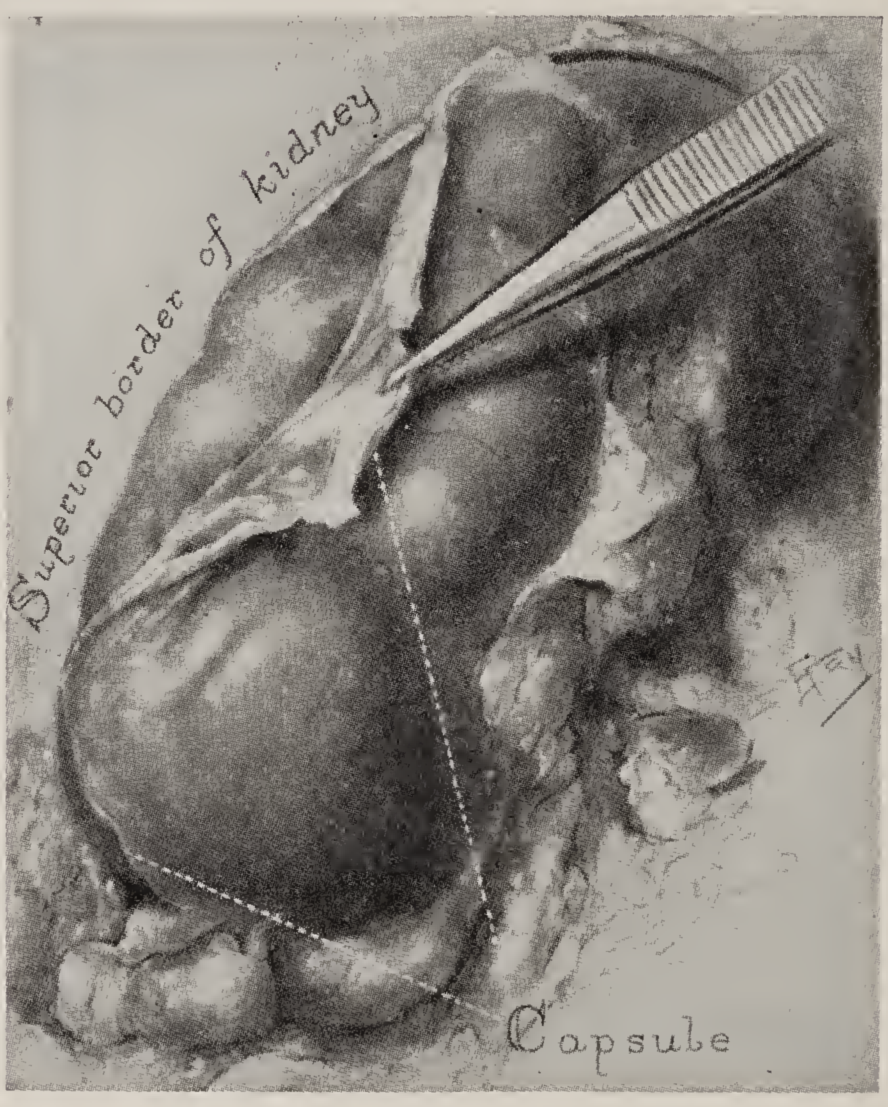

Fig. 288. Subcapsular Nephrectomy. Capsule incised along the superior border of the kidney and enucleation begun. (*Mayo.*)

In the larger number of cases in which nephrectomy was done there was pyonephrosis and stone, and nephrectomy was obviously the only treatment that could be considered. Four nephrectomies were performed following conservative operations for stone. In the small number remaining in which nephrectomy was done the function was so limited as to be negligible, but it would have been possible to save the remnant of the kidney. Should this have been done? Since stone did not form or re-form in the remaining kidney in any of these cases and no symptoms developed subsequently to indicate renal insufficiency we must conclude that the practice followed was sound. In most cases, nephrectomy is easily done through the incision described, but in some cases, especially of pyonephrosis, the kidney may be encapsulated by a

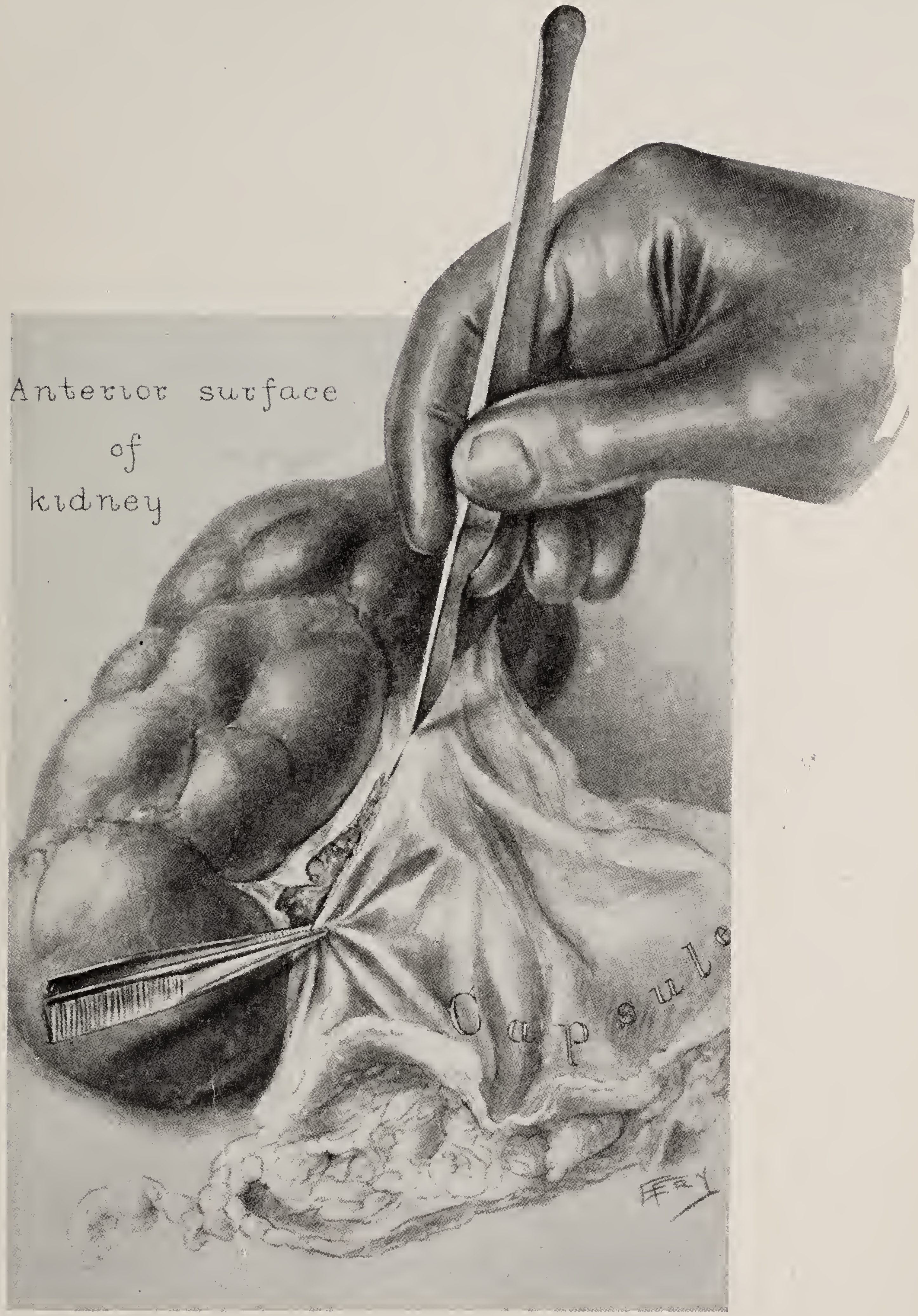

Fig. 289. Subcapsular Nephrectomy for Pyonephrosis, Kidney drawn outside of the Capsule. Incision being made which separates the capsule from the kidney sinus. (*Mayo.*)

massive wall of connective tissue and the attempt to remove it with the protective wall may cause the accidental opening of the pleura or more often of the peritoneal cavity. While neither of these accidents is of great moment (and I have never seen trouble follow if the pleural or peritoneal rents were promptly sutured with catgut), it is at least unnecessary. The most serious risk in the removal of such a kidney with its capsule lies in the fact that on the right side the vena cava or the duodenum may be injured during the operation.

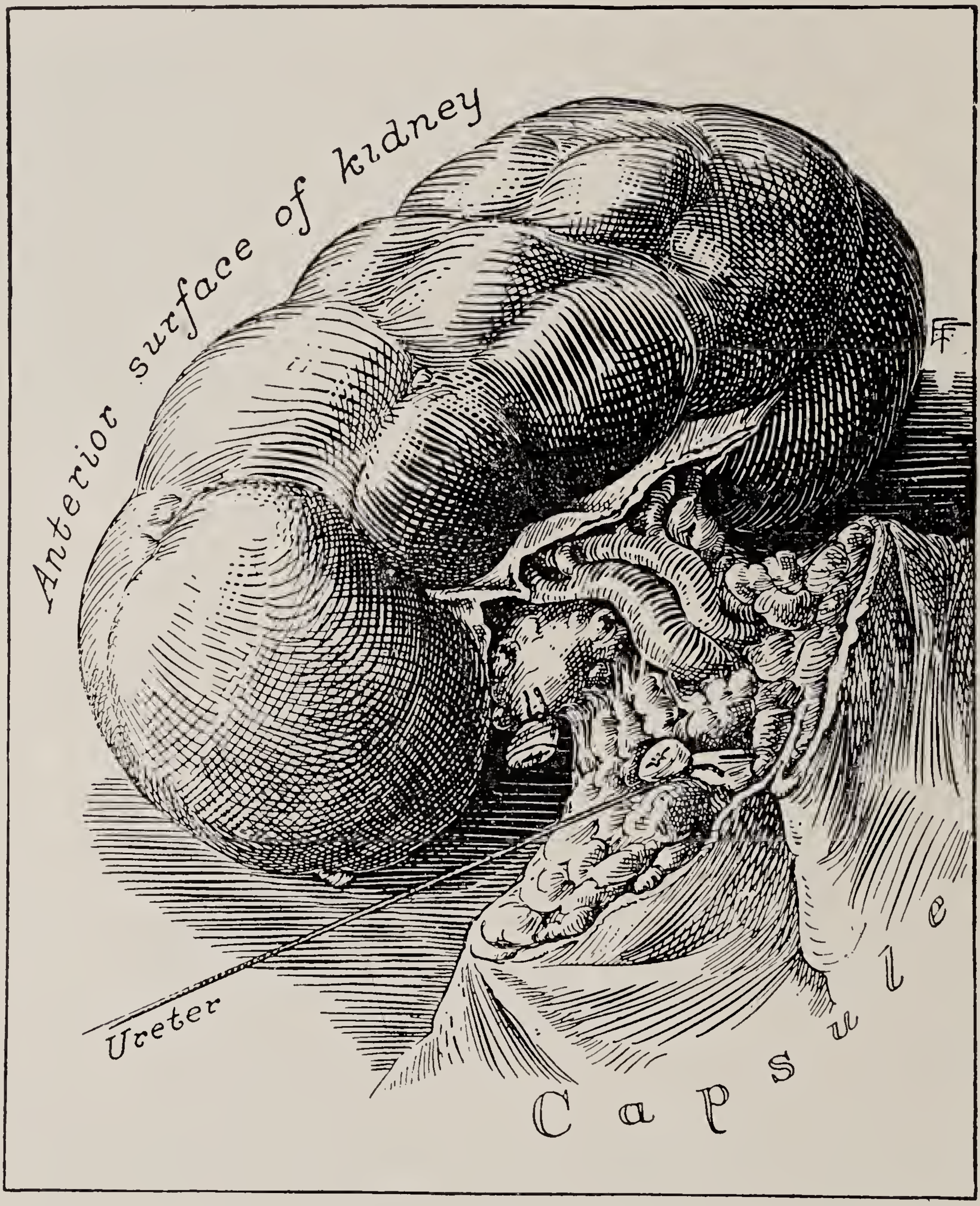

Fig. 290. Subcapsular Nephrectomy for Pyonephrosis. Ureter tied and divided. Kidney drawn away from the capsule, exposing the renal vessels. (*Mayo.*)

Tuffier's method of doing a subcapsular nephrectomy is well worth mentioning. After exposing the kidney, he makes an opening through the fibrous capsule down to the pyonephrotic sac and, with the hand, quickly decorticates the kidney. He then lifts it out from within the attached capsule which is turned back about the pedicle (see Fig. 288), places a pair of clamps across the pedicle, cuts the kidney away, and packs the cavity with gauze.

Federoff has made an addition to Tuffier's subcapsular nephrectomy which renders the securing of the pedicle extremely easy. Drawing the kidney out of its capsule, with a knife he separates the capsule from the sinus of the kidney as it is folded back over the pedicle. This allows the kidney with the renal vessels to be drawn through the capsule, top and bottom, and makes possible separate ligation of the vessels (see Fig. 289).

The most difficult nephrectomies are those which must be done following a nephrotomy which has left a fistula leading to a remnant of kidney. The safe way is to introduce a knife through the fistula to the kidney, and then split all the outer wall until a sufficient opening has been made for subcapsular nephrectomy (see Fig. 290). If forceps are left on the pedicle, the admonition of Price should be remembered: Unclamp the forceps at the proper time—48 to 72 hours—but do not remove them until from 8 to 12 hours afterward in order that the tissues firmly compressed may have an opportunity to retract. Should the forceps be removed at once after unclamping, the ends of the vessels in their bite may be torn apart, permitting hæmorrhage.

CHAPTER VI

NEPHRECTOMY

Indications. (1) Hæmorrhage from injury or from disease is a condition which may call for either partial or complete nephrectomy. Bleeding may be the only symptom, as, for example, in papilloma of the pelvis, early tuberculosis, carcinoma, renal varix, a hæmaturia from passive hyperæmia.

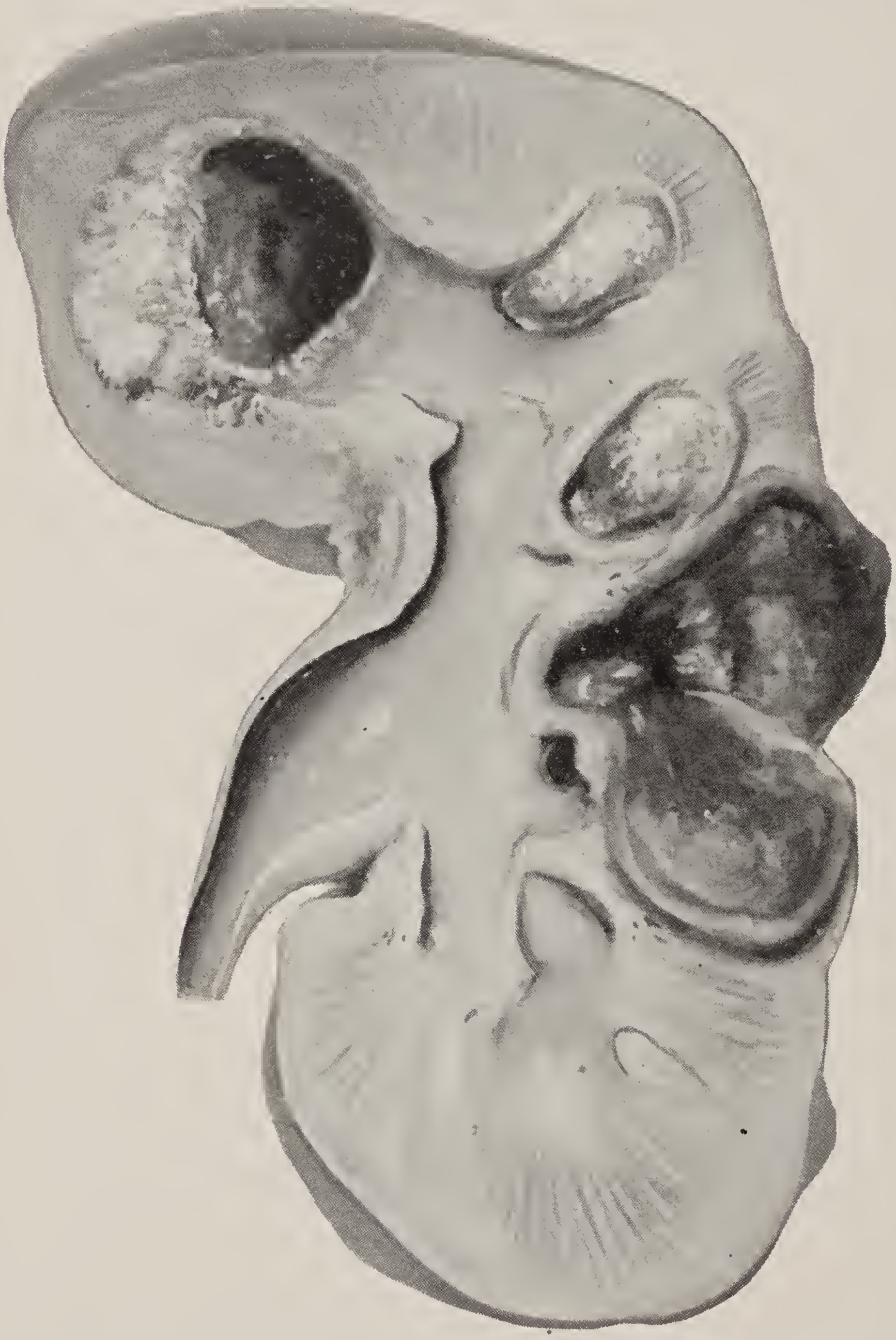

Fig. 291. Advanced Tuberculosis of the Kidney.

(2) *Tuberculous disease.* When the disease is limited to one kidney, as it usually is in the beginning, primary nephrectomy is the operation to adopt, and it may be undertaken with a very fair prospect of a favourable result. But if the disease has reached an advanced stage, probably a nephrotomy will be found more suitable in the first instance, and the question of a secondary nephrectomy may be left to be determined by the demands of the individual cases.

(3) *Malignant disease.* In *sarcoma,* so long as there is no evidence of secondary formations and the general strength of the child gives hope of success, an abdominal exploration should be made as early as

possible, and if the growth can be enucleated a primary nephrectomy should be performed.

In *carcinoma* of the parenchyma the disease remains localized for a considerable period. The great difficulty one has to contend with is that subcapsular carcinoma may be present for a long time without giving rise to a palpable swelling in the loin, pain, or other indication of its presence.

(4) *Injury.* When the symptoms indicate that the laceration of the kidney is severe, and there is danger of the patient bleeding to death, either from the escape of blood by the ureter or into the tissue surrounding the kidney, the surgeon is justified in cutting down upon the kidney and removing it if the organ be destroyed.

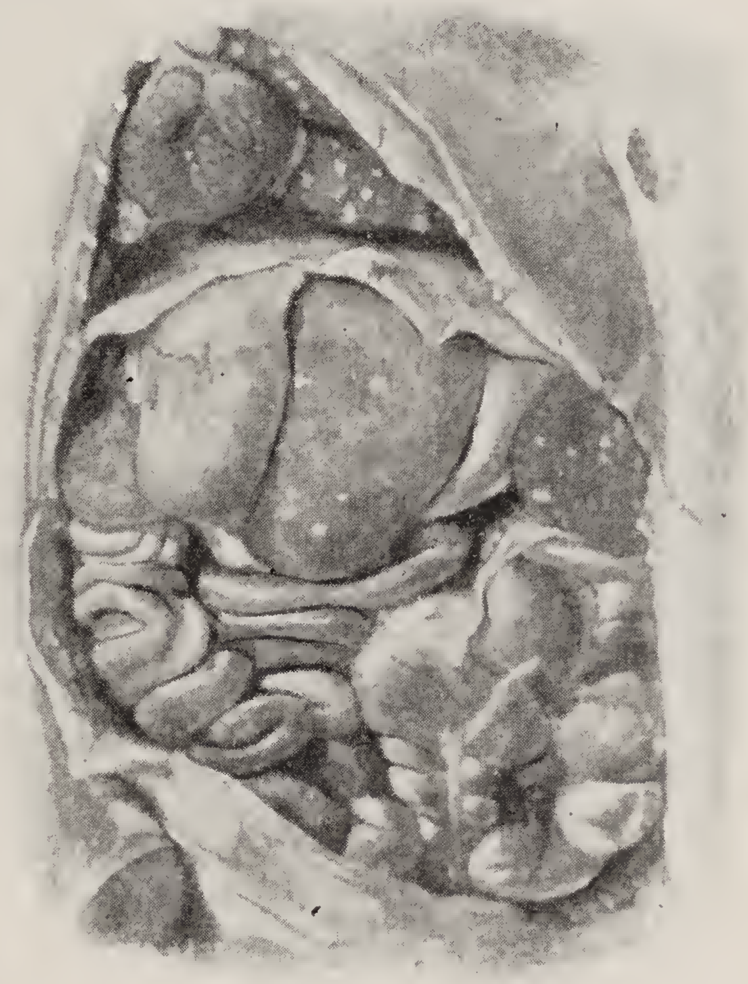

Fig. 292. The Abdominal Contents of a Guinea-pig killed four weeks after inoculation with Urine from a case of Tuberculous Nephritis. Showing miliary tubercles in the spleen, liver, peritoneum, omentum, and lungs.

It is obvious that when there is evidence of effusion of blood or of urine into the peritoneal cavity, immediate abdominal nephrectomy is indicated, and during the performance of the operation the kidney and spleen should be explored and any lacerations attended to; but when rupture of the kidney alone is suspected, and the hæmorrhage is not severe, it is well to delay interfering, so long as urine is freely excreted, as in a large proportion of cases palliative treatment is all that is required. Nephrectomy may be partial or complete, and the kidney may be excised either through a lumbar or an abdominal incision.

(5) *Septic infection with or without calculus.*

(*a*) When the kidney is so destroyed that it cannot do useful work, and the disease is reducing the patient's health from septic infection

(*b*) Recurrent calculus and permanent renal fistula.

(*c*) Obstruction to the ureter which cannot be remedied by a plastic operation.

There are many ways of doing the operation, and the chief arguments for and against the median and lateral abdominal and the lumbar methods of performing nephrectomy may be stated thus:—

The first method has been largely employed in the treatment of such conditions as hydronephrosis, cystic disease, and neoplasm—lesions in which considerable space is required for manipulation. In so far as it widens the field of operation, and gives the operator free access not only for the removal of the diseased parts and for the controlling of hæmorrhage, but also for the purpose of ascertaining, as far as is possible by palpation, the condition of the other kidney, this operation is to be commended. But while these advantages cannot be denied, it has been urged against both of the abdominal operations, but especially the median, that not only is the peritoneum wounded, but the mesocolon must be divided before the kidney is reached. Besides, as a consequence of the situation of the wounds and the circumstance that the peritoneal cavity has been opened, it is found difficult to drain away the blood and discharges without contaminating the abdominal sacs, and thereby increasing the danger of death from peritonitis.

Another, but what seems to be an unlikely drawback to the abdominal operations, is the supposed liability to ventral hernia at the site of the incision through a tense muscular abdominal wall. Taking all cases of abdominal section, in how many has ventral hernia been induced? Very few have been published, notwithstanding the large number of abdominal sections that are being performed yearly. The two most serious objections to the abdominal operations are the trouble occasioned during the operation by the intestine protruding through the wound, and the difficulty in procuring efficient drainage afterwards.

The advantage claimed for the lateral abdominal (Langenbuch's) incision, as compared with the median abdominal, is that by careful manipulation, even although the peritoneum be opened during the first stage of the operation, the kidney can be removed without danger of the cavity of the abdomen being contaminated by subsequently suturing the mesocolon to the margin of the anterior lip of the parietal incision.

Another reason why this operation should be selected is that, on account of the situation of the incision at the outer border of the rectus muscle, the kidney is easily reached and its vessels and ureter secured, while at the same time the large veins in the anterior layer of the mesocolon are avoided. By this operation good drainage is secured, and the wound is practically made an extra-peritoneal one.

The advantages of lumbar nephrectomy over the abdominal operations are that, unless by misadventure, the peritoneal cavity is not opened, the wound is easily and efficiently drained, and no structures are injured except those composing the parietal wall. But, on the other hand, on account of the small space afforded, the surgeon may experience difficulty in reaching and removing the kidney in some cases, and, as a consequence of awkward manipulation, the vessels of the pedicle have been lacerated and even the renal tissue ruptured.

LUMBAR NEPHRECTOMY

The kidney having been laid bare by the method described above (p. 549), the next step in the operation is to separate it from its surroundings, which is easy or difficult according as the surface of the kidney has or has not formed adhesions to the neighbouring parts. When the surface of the kidney is normal, the organ can be separated from the tissues around it with ease, either by the finger or by a periosteal elevator. This is frequently the case in such lesions as hydronephrosis, cystic disease, benign tumours, and renal calculus. But when the disease is of an inflammatory nature, or has led to perinephritis, the condition of matters is very different, and the difficulties of the operation are greatly enhanced by the adhesions which the indurated adipose capsule has formed with its surroundings. Consequently in such lesions as suppurative disease of the kidney, old-standing renal calculus, tuberculosis, and malignant growths, the operation is a more serious one in itself.

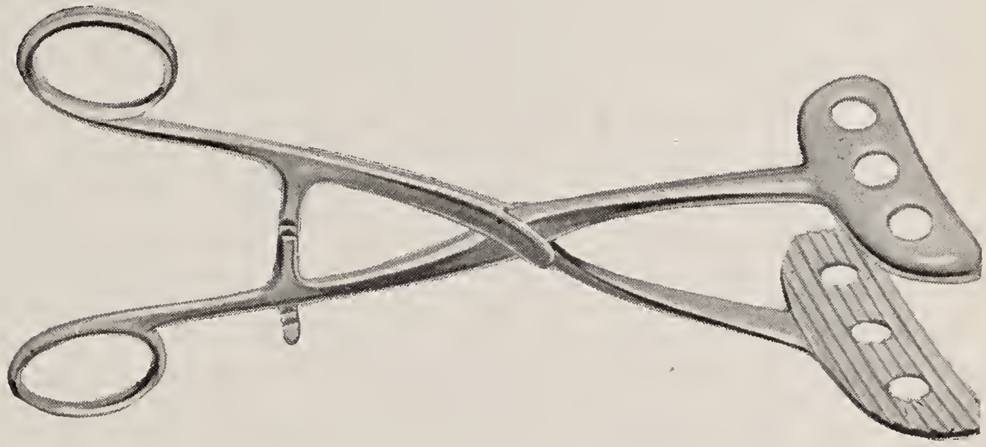

Fig. 293. Forceps for delivering the Kidney on to the Loin.

While, however, the adipose and fibrous capsules have become firmly adherent to their surroundings, the kidney itself may not be so strongly united to its capsule. Taking advantage of this circumstance, it is advisable that, instead of removing the kidney in its capsule, the kidney should be exposed, the fibrous capsule divided, and the organ enucleated from it. In doing this, however, there may be free hæmorrhage in a few cases, as frequently small vessels and sometimes large ones pass from the capsule to the surface of the kidney. This danger of hæmorrhage is not great, as the divided vessels when normal in size soon close.

It is otherwise when the indurated tissue around is injured. The tissue being not only vascular, but greatly indurated, the vessels passing through it gape when divided, and show no tendency to contract. Hence, the bleeding which occurs when the inflamed perinephritic tissue is cut or injured is a general oozing, large in amount and sometimes even dangerous.

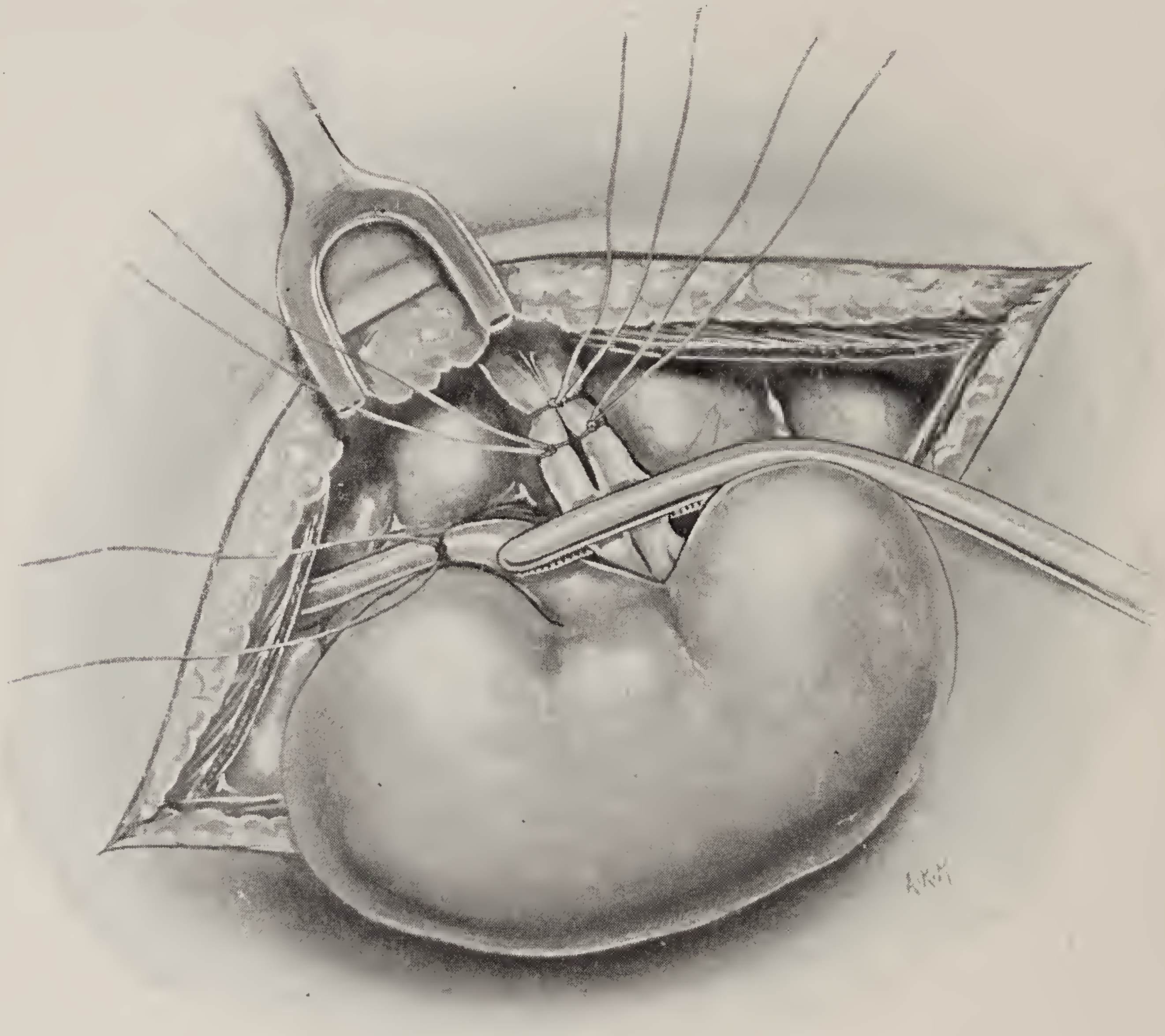

Fig. 294. The Pedicle of the Right Kidney clamped and tied.

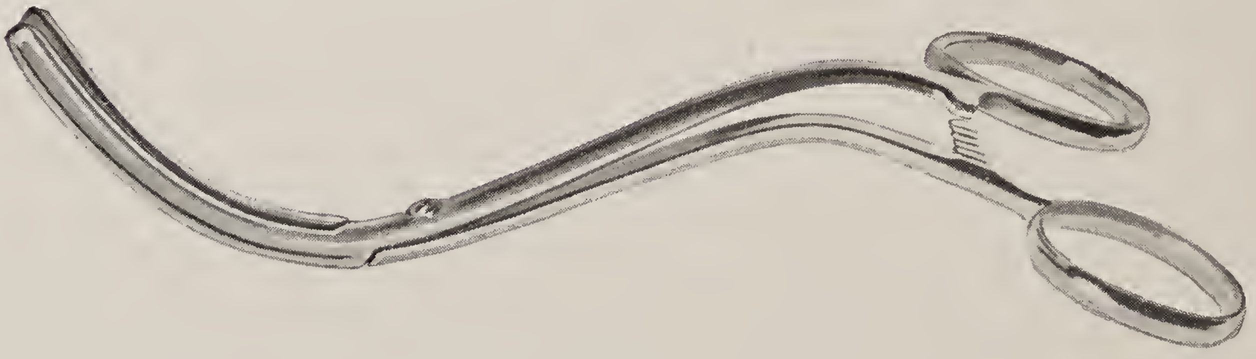

Fig. 295. Forceps for clamping the Renal Pedicle.

The kidney having been freed and delivered with the hand or with the help of forceps (see Fig. 293) and the pedicle exposed, it should be clamped with forceps (see Fig. 295), and a double chromic catgut ligature should be passed round the vessels, and another round the ureter, by an aneurysm needle (see Fig. 294). The kidney is then dragged gently outwards, and the needle having been withdrawn the ligatures are tied. While one set is made to include the vessels the other set secures the ureter. Having fixed the ligatures, the last step of the operation is proceeded with, and the organ is removed by cutting the pedicle between the ligatures as close to the hilum as possible with curved scissors cutting on the flat.

After the division of the pedicle the renal artery should be tied separately, also the vein, and the ureter should be traced down as low as possible, two ligatures applied, and the duct divided between them so as to avoid escape of contaminating fluid. The lumen of the stump should be painted with pure phenol and the end stitched carefully. Then a thorough search should be made in the interior of the wound, which is now easily inspected, for any bleeding points, and these having been secured a drainage tube is inserted, and the wound is washed out with an antiseptic solution. The lips of the wound are brought together, and an antiseptic dressing is applied.

ABDOMINAL NEPHRECTOMY

Abdominal nephrectomy may be performed either by an incision at the outer margin of the rectus muscle, or by one in the linea alba.

Lateral abdominal nephrectomy. In *transperitoneal nephrectomy* the abdomen is opened through the linea semilunaris, and the kidney exposed as described on p. 552 (Fig. 274). The intestines having been drawn well over to the healthy side, and protected with gauze pads, the wound in the parietes is widely retracted and the outer layer of the mesocolon exposed to view. The incision should be made along the outer border and parallel to the line of the colon (Fig. 275, p. 553), care being taken to avoid vessels of any size. This may be done by cutting at right angles to the first incision. As soon as sufficient space has been obtained the perinephric fat is seen and divided. The fatty capsule is cleared first from the posterior and then from the anterior aspect of the kidney, the organ is delivered through the abdominal wound, and the pedicle clamped, ligatured, and divided, as in the lumbar operation. All bleeding points having been secured, a drain is inserted through the lumbar region, the edges of the mesocolon are sutured, the anterior peritoneal wound is accurately united, and the structures of the parietes are sutured separately; drainage is secured through the incision in the loin.

This operation has been resorted to for large tumours of the kidney, especially in children, sarcomata, hydronephrosis, cystic disease, and severe lacerations of the kidney. It is especially useful in malignant neoplasms where it is necessary not only to remove the kidney and its surroundings, but also lymphatic glands and the whole length of the ureter.

It should not be employed in any septic lesions, on account of the liability of the peritoneum to infection; in such cases the lumbar operation is safer.

The paraperitoneal method may be carried out either by a transverse incision at the level of the umbilicus or by a ⊣-shaped incision. The main point in the operation is that the kidney is exposed by an anterior incision without opening the peritoneum. The patient is lying on his back, slightly inclined to the healthy side and a sand-bag is placed behind the lumbar region on the diseased side so as to press the thorax forwards. The incision is made through the skin, muscle, and fascia, a little outside the linea semilunaris, and extends from an inch below the free border of the tenth rib: it is carried obliquely downwards and forwards to within an inch of the anterior superior spine of the ilium, down to, but not through, the peritoneum. From the outer lip of the wound the peritoneum is easily separated by the surgeon, while his assistant gently draws the abdominal contents towards the middle line, and retains them there with pads. The perinephric fat can now be exposed, the capsule divided, and the kidney brought into view. When there are no serious adhesions, the detachment of the kidney is easy, first by freeing the anterior aspect, then the posterior, and finally the poles. The artery, veins, and ureter are easily isolated, tied, and divided, when the kidney comes away. If the opening is not large enough a transverse incision may be made at right angles to the perpendicular one, as far out as the edge of the quadratus lumborum. The eleventh intercostal nerve is the only one cut, and it can be avoided by keeping the incision in front of and an inch above the anterior superior spine. The tenth may be avoided by keeping the incision an inch below the tenth rib. The kidney is removed, and the wounds are closed as in the other operation. On account of the risk of hernia, suturing must be careful and accurate, the various structures of the parietes being united in layers with close-set interrupted or continuous thick catgut. The paraperitoneal route has advantages over the lumbar and the abdominal. In comparison with the former the surgeon can see better what he is doing, and consequently the kidney is more easily separated from its surroundings, while easy access is obtained to the pedicle, which can be freely exposed and dealt with in detail. Over the abdominal route it has the advantage that the peritoneal cavity is not opened and the mesocolon is not interfered with; it gives quite as free access to the kidney, and it is easier to retract the abdominal contents when the peritoneum is intact.

Median abdominal nephrectomy is now seldom employed; the lumbar and the paraperitoneal methods have all the advantages of a transperitoneal operation and the additional one that the peritoneal cavity is left unopened. The method of exposing the kidney has been described (p. 548).

Dangers of Nephrectomy. The causes of death in nephrectomy, in percentages, are as follows:

Uræmia and anuria	18.5%
Shock	30.2%
Death during operation	1.1%
Sepsis, peritonitis, &c.	21.0%
Hæmorrhage	3.2%
Rapid recurrence of disease	4.1%
Complications in other organs: empyema, pleurisy, pneumonia, Bright's disease, cardiac or pulmonary embolism, &c.	21.9%
	100.0%

Shock is one of the most serious dangers, but considering the general condition of many patients who are submitted to the operation, the mortality from this cause is not to be wondered at. Within late years the statistics have improved greatly, and this is accounted for by the fact that the surgeon is consulted at an earlier stage in the disease than formerly. Some cases do remarkably well for three or four days after the nephrectomy, but die suddenly from what has been called 'delayed shock,' attributed by some writers to interference with the solar plexus. Any such cases which have come under the observation of the writer have proved to be due to embolism on the right side of the heart, probably caused by a thrombus carried from the stump of the renal vein or vena cava. To avoid shock shorten the length of time occupied by the operation as much as possible, give 1/40 of a grain of strychnine subcutaneously before the patient leaves the operating room, and if the pulse is poor give intravenous injections of 1 to 1½ pints of saline or an enema of saline containing whisky, 2 ounces to the pint. Also see that the patient loses as little blood as possible during the operation.

Hæmorrhage. By clamping the pedicle before removal of the kidney and carefully ligaturing the individual vessels as well as the stump as a whole, comparatively little blood should be lost during the operation, and the danger of secondary hæmorrhage reduced to a minimum. It is where old inflammatory adhesions and large masses of indurated tissue have to be cut through that both primary and secondary hæmorrhage are to be feared. Beware of accessory arteries, which are very commonly seen to enter the kidney both at the upper and lower poles, and which are liable to be torn across in separating the capsule from the kidney.

Peritonitis is one of the special dangers of the transperitoneal operations, but even in lumbar nephrectomy the peritoneum is liable to become infected owing to the detachment of old adhesions; hence the advisability of performing subcapsular nephrectomy when it is possible. This method has the further advantage that the suprarenal body and solar plexus are not interfered with. If the peritoneum be opened in the lumbar operation it should be cleansed and sutured at once. It is a safe rule to follow that all septic and tuberculous lesions or conditions involving accumulations of fluid in the renal pelvis should be removed by the lumbar method, while abdominal nephrectomy should be reserved for the excision of large solid growths of the kidney.

Empyema. As has been pointed out previously, the diaphragm is very thin behind the kidney, and the pleura extends down to the twelfth rib. The writer has seen a number of cases in the post-mortem room where a congenital gap existed in the diaphragm which was plugged by the perinephric fat; had a nephrectomy been demanded in such a case the danger of opening the pleura would have been considerable.

Pulmonary and *cardiac embolism* may occur any time within a fortnight after the operation, even though the renal wound be completely healed. The course of events and the symptoms, of course, depend upon the thrombus being aseptic or infected; if the former, it is generally large in size and may lead to sudden death from cardiac failure; if the latter, probably the particles are small, and are more likely to induce septic infection of the lungs or general septic poisoning.

Anuria. If care be taken to ascertain exactly the power of action of the other kidney prior to the nephrectomy, and it is found to be sufficient and there is no organic disease present, the danger of anuria following the operation is not great. But if the estimation of the renal functions has not been gone into and carefully considered (see Chapter II) the surgeon need not be surprised if his patient meets with a mishap and he has himself to blame.

Urine, however, may fail to be secreted for many hours on account of shock and low blood-pressure, but so long as the patient does not show symptoms of uræmia—headache, contraction of the pupils, mental disturbance, twitchings during sleep, &c.—little need be feared from the anuria. The best remedy is intravenous injections of saline carefully regulated.

SECONDARY NEPHRECTOMY

The technique is similar to that for primary nephrectomy, only the operation is more difficult on account of adhesions between the kidney and the parietes.

In renal calculus, movable kidney with severe symptoms, or septic infections of the kidney, a radical operation is not to be performed in the first instance. Nephro-lithotomy, nephropexy, or nephrotomy with drainage is employed, and if these fail in effecting a cure, the question of nephrectomy may be considered. Again, when the diseased kidney is well-nigh destroyed, and the general health of the patient greatly impaired, it is well to do the minor operation to give time for recovery, and to enable the other kidney to compensate and take up the work of total renal elimination.

SUBCAPSULAR NEPHRECTOMY

In old-standing septic renal lesions or in cases where a nephrotomy has been previously performed, the fatty capsule may become converted into a firm mass of fibrous tissue fixed closely to its surroundings, so that to separate it would be a matter of difficulty to the surgeon and danger to the patient. In such cases it is well to cut through the united capsules and peel the fibrous capsule from the parenchyma of the kidney.

The capsule is stripped off from pole to pole-first from the posterior, afterwards from the anterior aspect of the kidney. The kidney is then dragged into a position which will enable the surgeon to secure the pedicle, but on account of the adhesions he is seldom able to deliver the kidney through the wound, and it is often impossible for him to see what he is doing, and he must be guided by the sense of touch alone. The first thing to do is to reach the pedicle and separate the ureter from the vessels. It should be ligatured independently, after which a clamp should be applied to the vessels and the kidney excised. The capsule is then cut in a circle around the stump, which allows the pedicle to be brought into view, by the capsule slipping back towards the great vessels. Ligatures are now applied to the vessels beyond the clamp, which may be removed, and the vessel caught up individually and ligatured again, as a ligature including the whole stump, embedded as it is in fibrous tissue, is liable to be insufficient. Sometimes it is well to leave the clamp in position for a few days instead of trusting to ligatures.

NEPHRECTOMY BY MORCELLEMENT

In cases where the capsule of the kidney cannot be freed sufficiently widely to permit of ligature of the stump, it may be necessary to remove the organ in separate pieces. The kidney having been exposed, the capsule is incised along the convex border and the lower pole as far as possible. Right-angled clamp forceps are now applied across the long axis of the kidney with sufficient force to stop the circulation in the lower third of the kidney. That part below the forceps is now removed and gives access to the pedicle. Curved forceps (Fig. 295) should then be passed from below upwards so as to grasp the whole of the pedicle. The remainder of the kidney may now be freed and clamp forceps applied so as to shut the blood off from the upper pole, which should be cut away above the clamp. Only the central portion of the kidney is now left, the cut surfaces of which have been clamped. A strong ligature should now be applied to the pedicle and the central portion of the organ excised. Whether the clamp forceps should be left in position or removed must depend upon the circumstances of the case.

PARTIAL NEPHRECTOMY

Resection of portions of the kidney has been employed in cases of rupture of the kidney, in benign tumours, paranephritic growths, hydatid cysts, serous cysts, cystic tumours, renal fistulæ, and limited tuberculous lesions, but in most instances its indication has only been discovered during an exploration of the kidney, not demonstrated clinically beforehand. Where it is possible to save only a portion of the kidney it is well to do so, as compensatory hypertrophy occurs in the remaining renal tissue of the resected organ as well as in the opposite organ. The kidney having been exposed and delivered, the vessels are gently clamped, so as to prevent bleeding and to give a clear view of the lesion. The disease having been located, and found to be a condition that can be suitably treated by excision of a portion of the kidney, the organ is held by an assistant, while the surgeon cuts out a wedge-shaped piece including the whole of the disease and a margin of healthy renal parenchyma all round. It is right to have a clean-cut surface, and the part removed of a regular form. In this way the surfaces can be accurately approximated, the sutures being introduced as in Fig. 285. Fairly thick catgut mattress sutures should be introduced through the capsule deep into the substance of the parenchyma, and brought out on the other side at right angles to the incision, the number varying with the depth and length of the wound. The sutures must include the capsule, and not be tied tightly, as they are liable to cut into the parenchyma when the clamp is removed from the pedicle and the cortex swells out with blood. In this way bleeding is prevented, and good apposition is soon followed by firm union, as healing of healthy renal tissue takes place with ease and rapidity. The clamp on the pedicle should be removed after the kidney has been sutured. A drainage tube is fixed in the lumbar wound, but not in the kidney, and no packing should be employed.

CHAPTER VII

OPERATIONS UPON THE RENAL PELVIS AND THE URETER

METHODS OF EXPOSING THE PELVIS AND URETER

TRANSPERITONEAL EXPOSURE

The ureter may be exposed either by a transperitoneal or by an extra-peritoneal operation, but the former is now only employed when the surgeon is uncertain as to the situation and nature of the obstruction, or is doubtful as to whether one or both ureters are involved. A median incision may be employed under such conditions, but if there be no doubt as to which ureter is affected, the incision should be made along the semilunar line and curved towards the middle line at its lower end. There are many objections to the transperitoneal method: unless the ureters be considerably altered by disease they are difficult to find behind the abdominal viscera; the peritoneum is opened both behind and in front, and in the event of any leakage of urine from the ureter may become infected; the position of the wound does not permit of free drainage; and, finally, no additional information can be gained which cannot be ascertained by other and safer methods.

Operation. After the abdomen has been opened, the first point is to ascertain the position of the kidney and find the hilum. Then, passing the fingers downwards in front of the psoas muscle, the ureter may be traced as low down as the bifurcation of the common iliac artery. When diseased and distended, the ureter is more easily traced than in health, and often the stone can be felt occupying its lumen, while above the obstruction the greatly distended ureter is easily traced behind the peritoneum; indeed, it may be so dilated that, were it not outside the peritoneal cavity, it might be mistaken for small intestine. When the ureter is not the seat of serious pathological changes, when the subperitoneal fat is abundant and the intestine is over-distended with gas, much difficulty may be experienced in tracing the course of the duct. The point at which it is most easily detected is where it crosses the brim of the pelvis. The method of opening the ureter is described on p. 603.

EXTRA-PERITONEAL EXPOSURE

This route is the one almost exclusively employed in exposing the ureter. During the early stages of the operation the position of the patient is similar to that for renal operations (see p. 550), but it is well to have him placed upon his back with the legs flexed and the thighs brought well up over the abdomen while exploring the pelvic portion of the duct.

The ureter may be exposed without opening the peritoneal cavity by any of the following routes:

1. The lumbar route prolonged extra-peritoneally.
2. The paraperitoneal route used in exposure of the kidney by stripping the peritoneum from the abdominal parietes.
3. The hypogastric route, opening the bladder above the pubes and catheterizing the ureters.
4. The sacral route.
5. The perineal route.
6. The vaginal route.
7. The vesical route.

The lumbo-ilio-inguinal route is the one to be recommended in the great majority of cases, the exceptions being those in which the calculus or stricture is known to be in the pelvic segment of the ureter.

The incision usually employed commences an inch below the last rib at the outer edge of the erector spinæ muscle, and extends inwards and downwards in front of the anterior superior iliac spinous process (Fig. 296). The distance to which the incision is extended inwards depends upon the necessities of the individual case. If the patient be short and stout, the space may be increased by making a T-shaped addition to the above, or by incising a portion of the quadratus lumborum.

When the fascia transversalis has been exposed and divided the colon is seen. It should be retracted, and the hand introduced through the wound behind the peritoneum, when the kidney can be felt embedded in its adipose capsule. The soft fat is easily separated from the kidney, and after the organ has been fully exposed a systematic examination must be made before it is disturbed from its bed. The ureter should be searched, and if a stone be found, it may sometimes be pushed up into the pelvis and removed by an incision through the convex border of the kidney; generally this is easily accomplished, as the ureter is dilated above the point of impaction of the stone, but if it be firmly fixed an incision should be made through the wall of the ureter above the level of the stone, and after the calculus has been extracted the incision may be closed by sutures.

If the kidney has been removed and the tissues around it be indurated and adherent, it is very difficult to detect the ureter. Under such circumstances it is necessary to trace the ureter from below upwards, beginning at the point where it passes over the brim of the pelvis, or where it crosses the iliac vessels. In disease it is usually more easily discovered than in health, but on account of prolonged irritation the peritoneum is more firmly adherent to it than under normal conditions. When the duct is discovered by the forefinger the intestine and the peritoneum should be gently pressed aside with a thin gauze pad held by an assistant, in such a way as to leave the ureter freely in view. The serous membrane should then be carefully dissected from the duct as far down as may be necessary. Whether to separate the ureter upwards or downwards from the point in view is easily determined by its lumen; the duct is always distended above the point of obstruction.

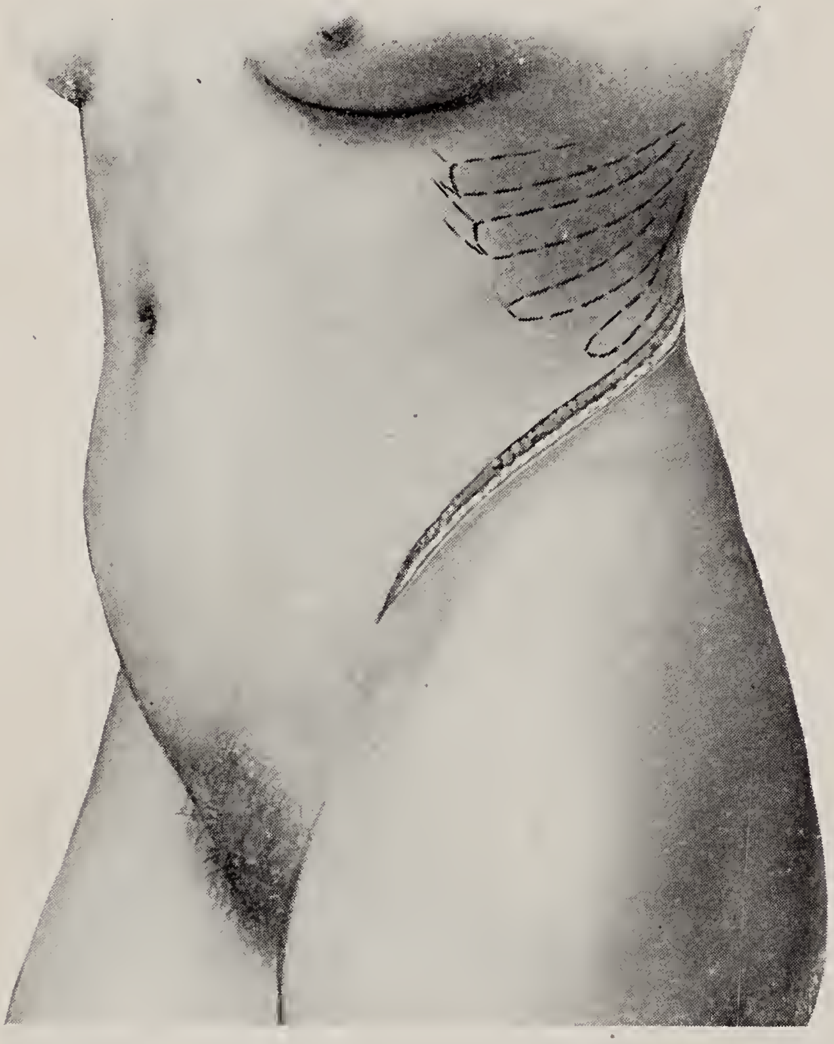

Fig. 296. The Lumbo-ilio-inguinal Incision for exposing the Ureter.

The pelvic segment can only be seen by extending the incision in the parietes well forwards, but before doing this it is well to pass the forefinger down into the pelvis and explore, and not infrequently, if the obstruction be due to stone, the concretion can be displaced so as to be brought into view without enlarging the opening.

A difficulty occasionally met with, which should be kept in view, is the lodgement of the stone in a diverticulum of the ureter, so that while the concretion is not in the lumen of the duct its presence causes distortion of the passage and obstruction to the escape of urine (see Fig. 297).

In opening the ureter, an oblique incision should be employed rather than a longitudinal one, which is liable to produce diminution in the

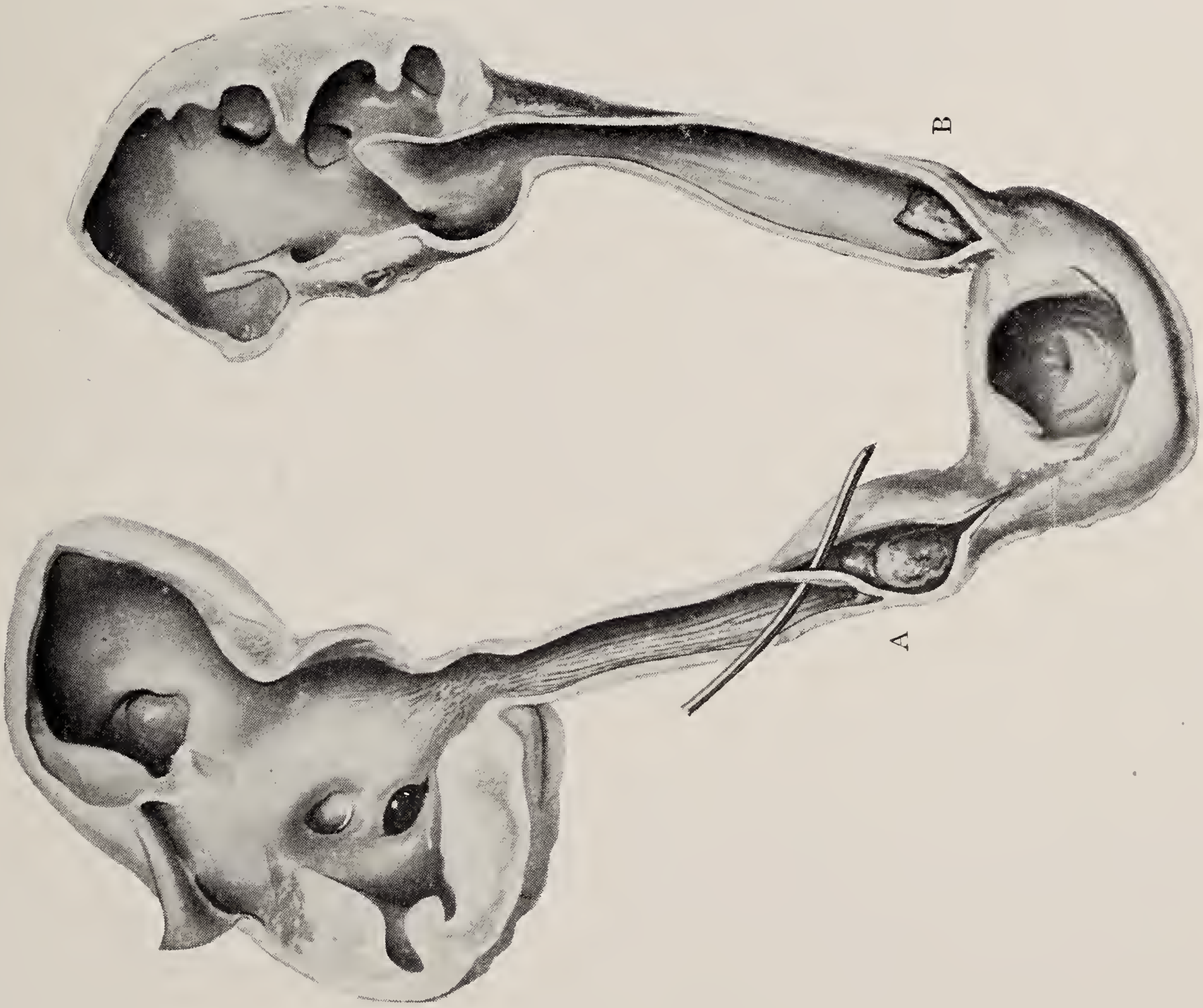

Fig. 297. Calculi impacted in both Ureters. The stone A is in a diverticulum, the stone B is in the duct itself.

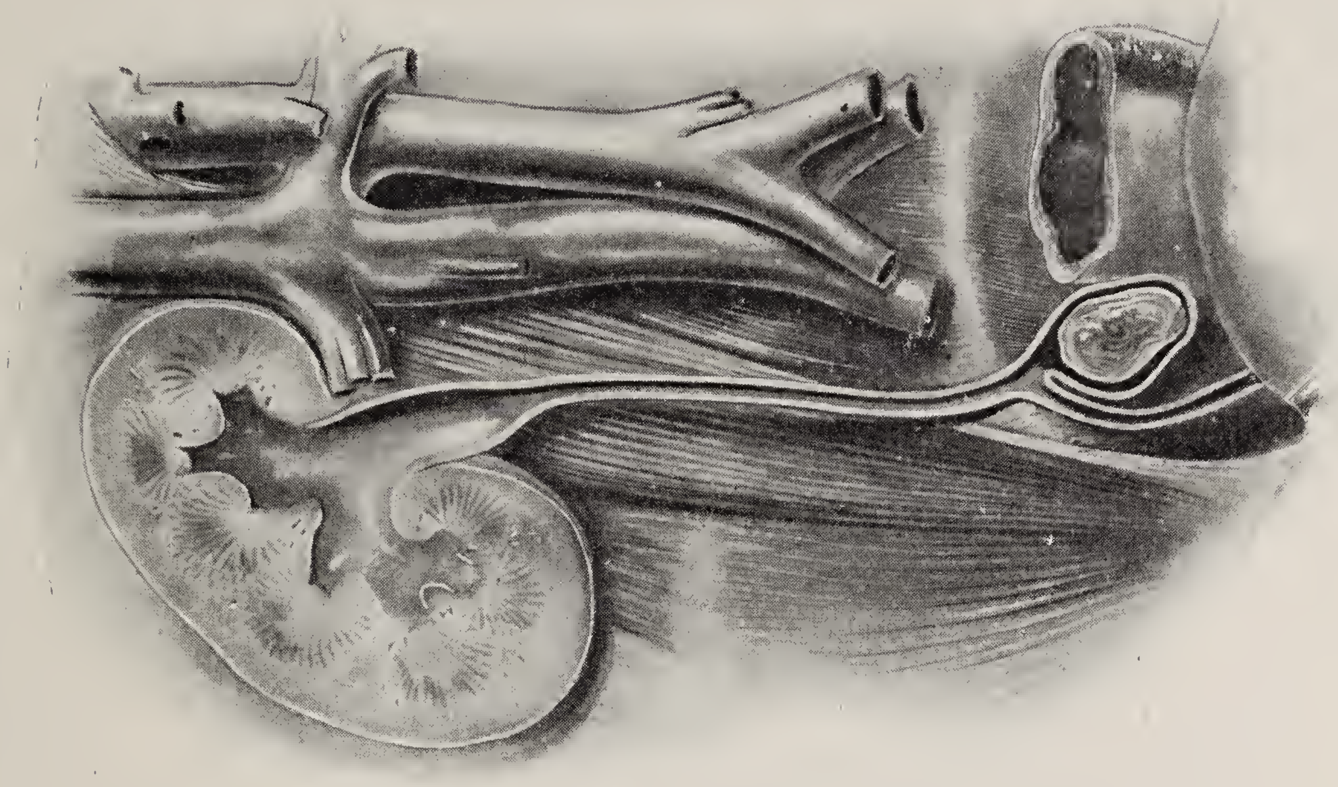

Fig. 298. A Calculus in a Diverticulum in the Right Ureter.

lumen of the duct by the suturing, while a transverse incision is likely to be followed by a fistula.

When only the pelvic portion of the duct requires to be exposed, the incision through the parietes may be limited. Instead of starting from a point an inch below the last rib, the incision may be made as for tying the common iliac artery, commencing immediately outside the centre of Poupart's ligament and 1½ inches above it; this incision is carried outwards towards the crest of the ilium, then upwards and slightly inwards. The abdominal muscles are cut through till the fascia transversalis is reached; it is picked up and divided and the extraperitoneal fat is exposed to view. The peritoneum is then separated, and, with the bowel, is held to one side by an assistant while the surgeon explores the posterior wall of the bladder for the ureters. Owing to the small size and depth of the wound, it is necessary to throw light into it with an electric forehead-lamp or a mirror.

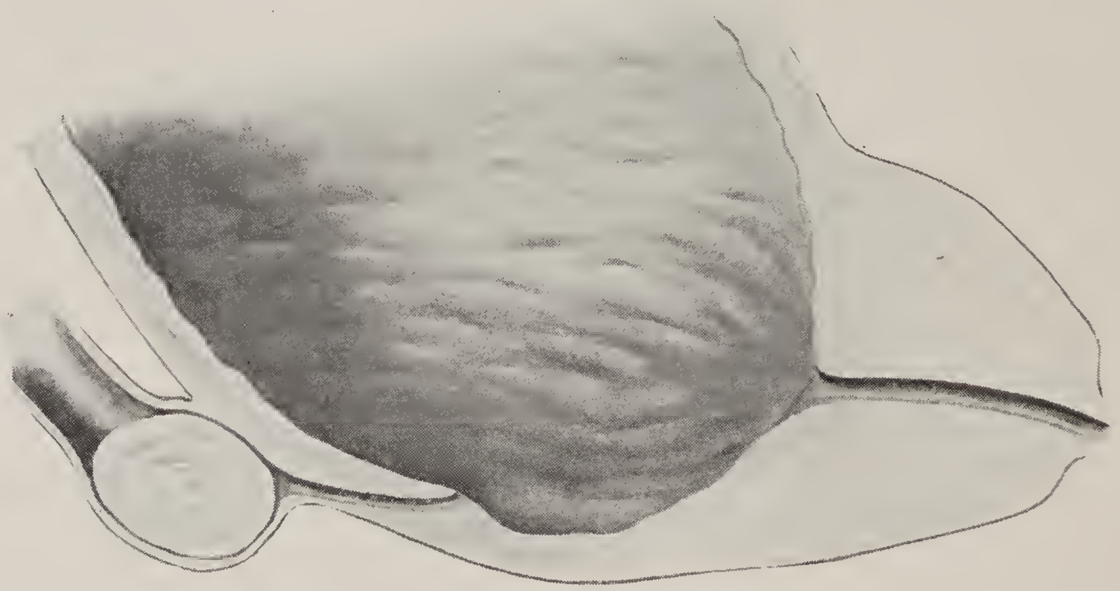

FIG. 299. IMPACTED URETERAL CALCULUS. The stone is arrested at the point where the ureter enters the bladder-wall. The duct is distended above the obstruction.

The paraperitoneal method is carried out in the following way: The patient is placed on his back and an incision is made ½ inch to the outer side of the linea semilunaris, beginning close to the border of the ribs and descending to the anterior superior spinous process of the ilium. The parietes are divided down to the peritoneum, the cavity of which is not opened, but the membrane is separated from the abdominal muscles gently by the hand of the operator and, along with the abdominal contents, is dragged towards the middle line by an assistant. The kidney with its surrounding fat is then brought into view and the ureter exposed and examined as described above.

Should the patient be short and stout, it may be necessary, in order to gain sufficient room, to make an incision at right angles to the first one, possibly as far as the quadratus lumborum. The advantage of this method is not so evident in operations upon the ureter as when lesions of the kidney require to be dealt with, but it is certainly to be preferred to the transperitoneal route.

When old adhesions have formed, the peritoneum is very liable to be torn, and should this accident occur the wound must be carefully sutured before the ureter is opened.

The hypogastric route has been occasionally employed by the writer for the removal of calculi. If the stone has passed through the muscular wall of the bladder and pushed the mucous membrane in front of it, the appearances presented by the cystoscope are liable to be mistaken for those of a tumour. In employing this method, the bladder is opened by a suprapubic incision (see p. 618) and the intramural segment of the duct is examined with one finger in the bladder, the other in the vagina or the rectum (see Figs. 299–300). It may be possible to grasp the impacted body with forceps, and by careful manipulation drag it away without making any incision in the vesical wall; but if the stone be too large for this, it is well to make a small incision and dilate the ureter with sinus forceps before attempting to extract the calculus.

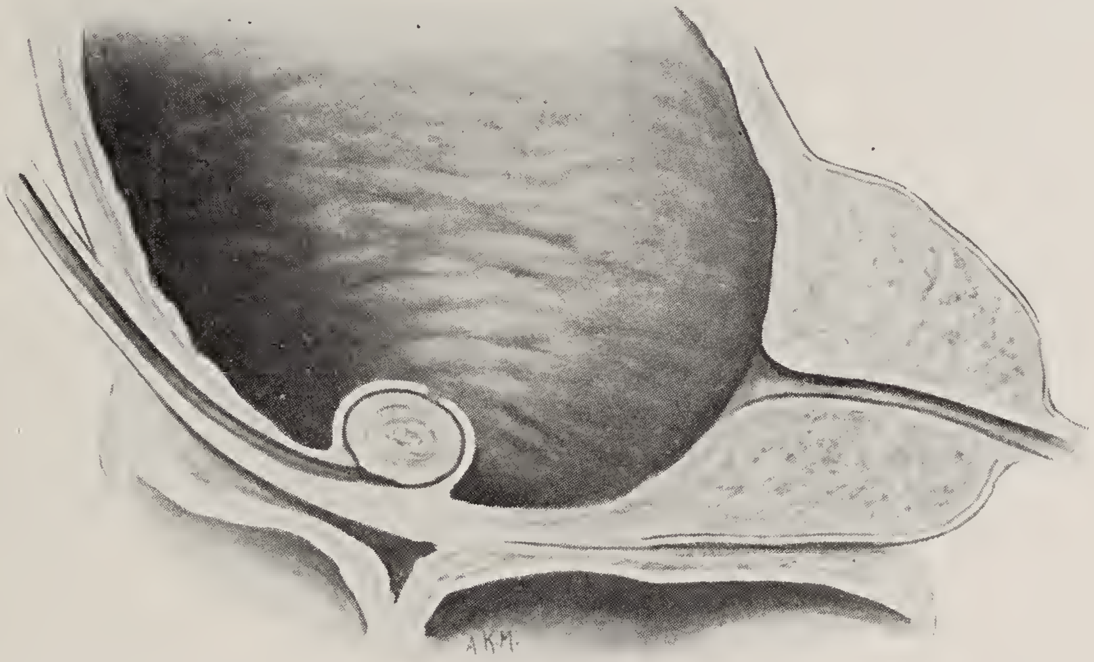

FIG. 300. CALCULUS IMPACTED AT THE VESICAL ORIFICE OF THE URETER.

The sacral route has been employed by Sir Henry Morris (*Surgical Diseases of the Kidney and Ureter*, 1901, vol. ii, p. 526) for the removal of a calculus impacted 2½ inches from the orifice of the ureter. He describes the method as follows: 'I employed a straight incision parallel with the median line and 1 inch from it, 5 inches in length, commencing about 2 inches above the border of the gluteus maximus muscle, and extending nearly to the transverse level of the anal aperture but a little behind it. The edges of the gluteus maximus and great sciatic ligament were divided, and the rectum and vagina were pushed towards the opposite side by breaking through the cellulo-fatty tissue between them and the pelvic wall by means of the forefinger and a few touches with the scalpel. In one of these cases the dorsal position, with the haunches well raised on a firm pillow placed beneath the loin, was found to facilitate the identification, isolation, and removal of the lower end of the ureter; in the other case the patient had to be turned upon her back before it was possible to fix the calculus. This was done by the forefinger in the vagina, and the patient was again placed on her opposite side with her face downwards and the calculus cut down upon and extracted.'

The perineal and the vaginal routes are also used for the removal of stones impacted close to the bladder, and for plastic operations for the cure of uretero-vaginal fistulæ. In the latter very good results have been got.

Ceci has removed a ureteral calculus through the rectum, and Fenwick has employed a perineal incision; removal through the vagina has been employed by the writer and others. In such cases the ureter is dilated above the point of obstruction, so that it can be easily felt with the finger. The patient is placed in the gynæcological position. The ureter and the stone should be fixed by a small sharp hook, and an incision is then made through the vaginal wall, cutting on the stone; when this is completed a rush of urine takes place, and the calculus escapes along with it. A catheter or sound should be passed up the ureter to the pelvis of the kidney to see that no other stones are impacted higher up. The opening may be closed with sutures, but probably it is safer to keep it open for a time by passing a drainage tube into the dilated ureter.

VESICO-URETERO-LITHOTOMY

In the male, when the stone becomes arrested where the ureter enters the bladder wall, by doing a suprapubic cystotomy the calculus may be removed. The patient is placed in the Trendelenburg position. With the finger in the rectum the stone is fixed in position by an assistant, the bladder is opened, and a small probe-pointed grooved director passed into the ureter from the bladder; the ureter is slit up for a third of an inch, fine sinus forceps are inserted and the stone is extracted.

As the ureter is always distended above the obstruction it may be difficult to fix the stone, which is apt to recede upwards and evade the grasp of the forceps.

OPERATIONS ON THE RENAL PELVIS

Pyelotomy has been considered on p. 573, also the question of the removal of a stone from the renal pelvis (see p. 574).

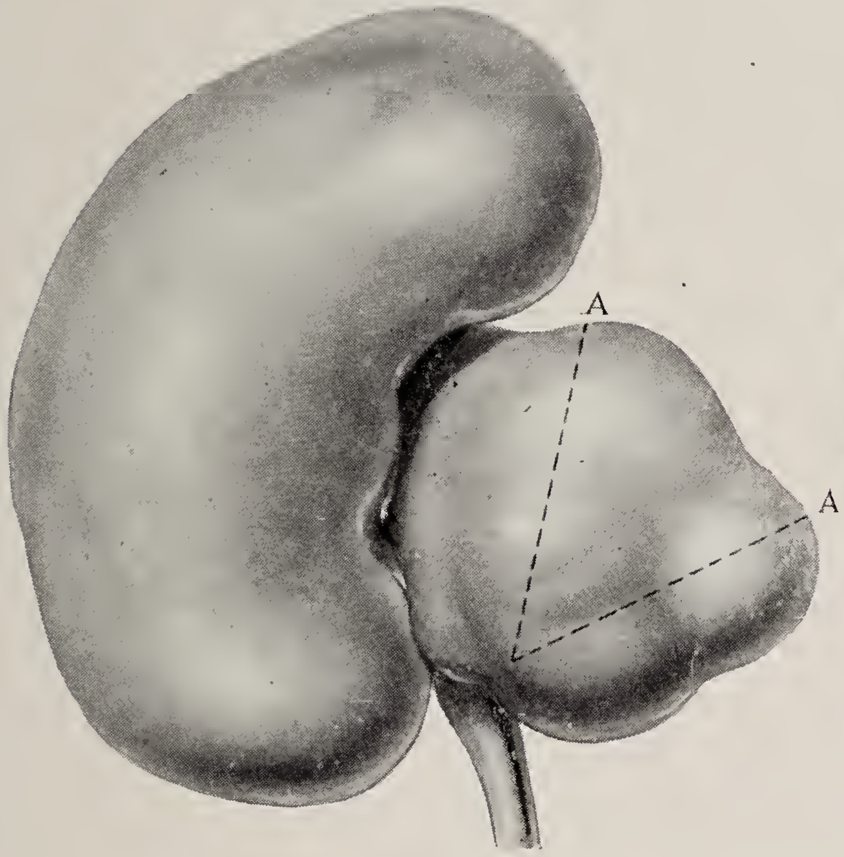

Fig. 301. Oblique Insertion of the Ureter into the Pelvis of the Kidney. The dotted line shows the segment to be removed. a and a are brought together subsequently.

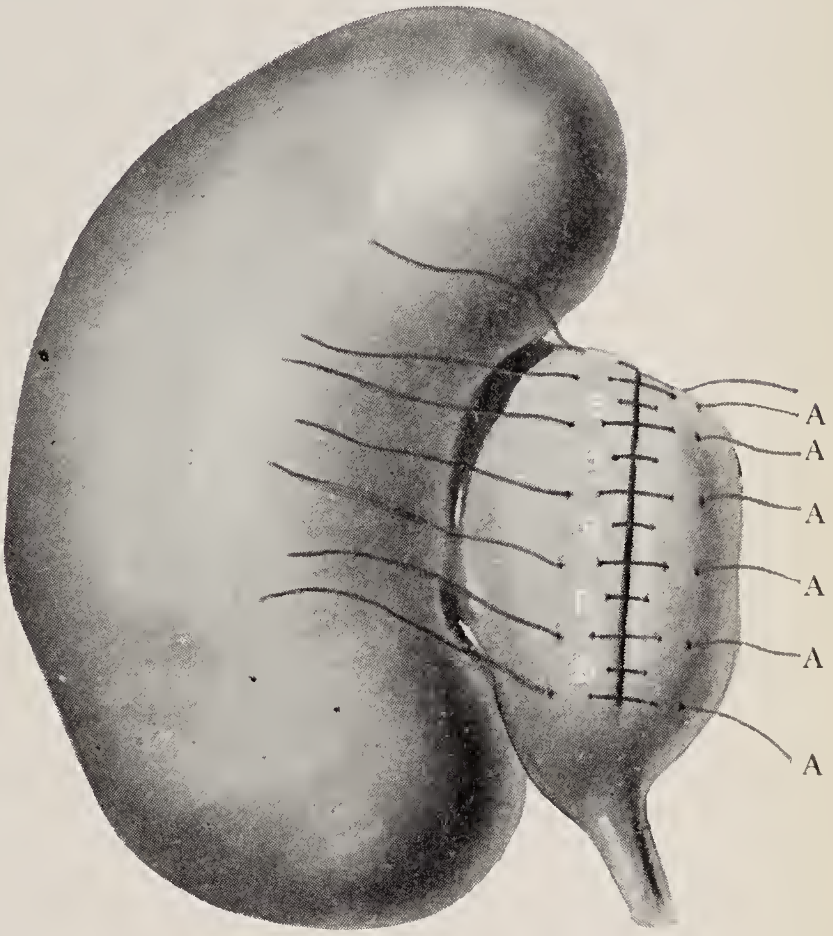

Fig. 302. Method of suturing the Pelvis after Resection. a, a, a, Lembert sutures. The others, b, are interrupted catgut sutures.

PYELO-URETEROSTRESIS

When there is obstruction at the junction of the infundibulum and the ureter on account of distortion or distension of the renal pelvis, the malformation may be rectified in various ways, according to the precise distortion which is producing the obstruction. Generally the obstruction is due to oblique insertion of the ureter into the pelvis of the kidney (see Fig. 301).

Operation. The kidney is exposed, the precise condition of matters is ascertained, and an attempt is made to bring the physical condition as near to normal as possible. This can frequently be done by resecting a portion of the pelvis of the kidney, but the part to be removed depends entirely upon the condition found. When the distension is limited to the upper part of the pelvis, a segment of the sac can be removed and the cut edges united by interrupted sutures (see Fig. 302).

When the lower part of the pelvis alone is distended and the ureter enters the sac at its uppermost limit, the best plan is to divide the sac on its outer aspect along with the ureter on its inner aspect, and to stitch the cut edges of the two structures to one another. The object is to bring the ureter into communication with the most dependent portion of the sac, and in order to do this it may be necessary sometimes to remove a portion of the ureter and to suture the lower segment to a new opening in the pelvis, while the upper segment is removed, and the cut margins of the pelvis are brought together with interrupted sutures.

OPERATIONS ON THE URETERS

URETEROTOMY

Ureterotomy includes simply opening the ureter in some part of its course, and how this should be done and the difficulties encountered in doing it are the points now to be considered.

Operation. The duct should be clearly brought into view, being freed as far as possible from its attachments, but at the same time care must be taken not to injure the peritoneum, the blood-vessels, or the spermatic cord. Instead of bringing the ureter out of the wound, an electric forehead-lamp or a good forehead-mirror should be used to throw a strong light into the depths of the wound, the operating room being darkened. Only about half the circumference of the duct need be cleared. An oblique incision is preferable to a longitudinal one, as the suturing of the edges is less liable to lead to constriction of the lumen than when a longitudinal incision is employed. Another method is to make a longitudinal incision, but to suture it so that the cicatrix is transverse (see Fig. 308), whereby the lumen, in place of being diminished, is rather increased. This method is, however, not always permissible on account of traction on the duct. When, however, the ureter has been dilated above the site of operation, there is generally plenty of tissue to work upon. When operating for stricture, the ureter should be opened at the dilated part above the obstruction, a director introduced, and the stricture divided upon it.

When the aim of the surgeon has been attained, the wound in the ureter should be closed by fine catgut sutures placed ⅛ inch apart. These are introduced by a fine curved intestinal needle, which is made to penetrate the wall of the ureter with the exception of the mucous coat. While wounds of the ureter may doubtless heal without suturing, it is much safer to employ them, if Lembert's method be adopted and catgut be used.

URETERO-LITHOTOMY

When the ureter is exposed for the removal of a stone, if it be found that the calculus can be displaced from its bed and pressed upwards, the opening in the duct should be made in the dilated ureter well above the point of impaction. By adopting this plan the incision is made through comparatively healthy tissue, whereas if the cut is made directly over the concretion it passes through unhealthy tissue, the mucous membrane is apt to be eroded, and the walls of the ureter become thin and friable. After the stone has been brought to the opening in the ureter, difficulty may be found in removing it, as, if smooth and rounded, it may repeatedly slip away from the grasp of sequestrum or dressing forceps. In such cases the writer has used cup-shaped forceps similar to Mackenzie's laryngeal forceps (see Fig. 303), or a small lithotomy spoon. Again, in cases of phosphatic concretion associated with bacillus coli infection, the stone may be so friable that it breaks into small fragments as soon as it is grasped with forceps. Here again a spoon is useful. After the stone has been removed, the ureter sound should be passed upwards and downwards to make sure that the duct is patent, that all concretions have been removed, and that no stricture remains.

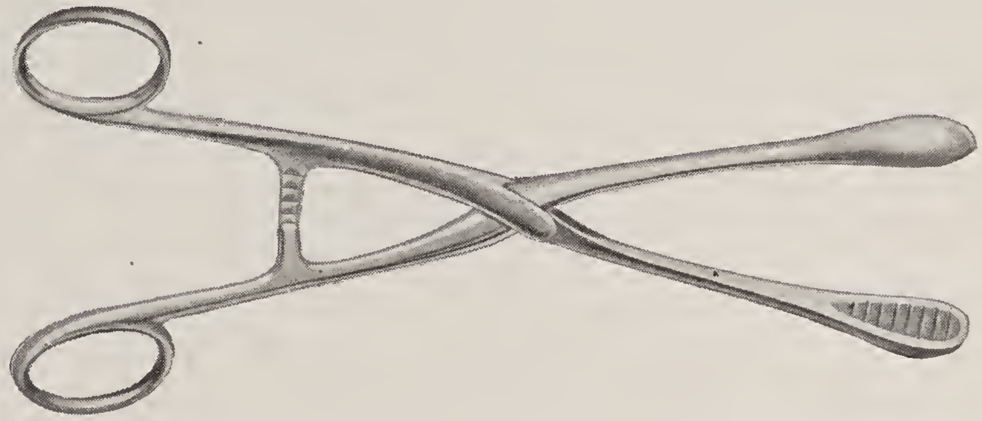

Fig. 303. Ureteral Forceps. Cup-shaped forceps with a special joint so that each limb can be introduced separately and locked when the stone is between the cups.

URETEROSTOMY OR DERMATO-URETEROSTRESIS

Transplantation of the ureter on to the loin is now frequently adopted, and the urine is drained into a suitable vessel, when it is found necessary to divert the secretion from its natural channel; for example, in ectopia of the bladder, in removal of the bladder for malignant disease, or in certain cases of tuberculosis.

Operation. The incision is made parallel with and 1¼ inches above the crest of the ilium, the muscles are divided, and the peritoneum is exposed and pressed towards the middle line without the cavity being opened. The ureter is exposed where it crosses the iliac artery, ligatured in two places, and divided. The lower ligature is cut short, the upper is allowed to remain long. A seton lancet threaded with the suture is then passed through the abdominal walls, so as to come to the surface close to the border of the quadratus lumborum, and the ureter, carefully freed from its attachments, is dragged through after it and drawn out beyond the surface of the skin. The end of the duct should then be split open for about 1/3 inch longitudinally, and the two flaps folded over the skin, to which it is sutured.

Care must be taken that there is no kinking of the ureter, and to prevent this a ureter catheter should be retained for four or five days until adhesion forms between the ureter and the parietes.

Implantation of the ureter on the skin has been resorted to in a considerable number of cases, Le Dentu being the first to employ it; but it seems to be justified not only in the conditions above mentioned, but also as a temporary measure or to save the patient from immediate death by anuria. It should only be resorted to when, owing to loss of substance, no other method is possible, or to tide over a critical period, after which another implantation may be made or nephrectomy performed. As a rule, if implantation cannot be made into some part of the urinary tract, and the kidney on the opposite side is healthy, nephrectomy should be performed.

ENTERO-URETERAL ANASTOMOSIS

The purpose of this operation is to lead the urine into some part of the intestinal tract, and it has been applied mostly in cases of ectopia vesicæ. It is described and illustrated by Mr. Thomson Walker (see p. 671).

This method is applicable to extroversion of the bladder only. For other conditions implantation of the ureter into the bowel should be avoided. Experimental implantation into the rectum, the colon, and the small intestine has been studied by Rosenburg, Novaro, Morestin, Tuffier, Gluck and Zeller, van Hook, and many others, but the operations performed upon animals contrast unfavourably with those undertaken on man. According to Bovee, bowel implantation has been done sixty-five times on man with a mortality of 30%, and a little less than a half of these deaths were from subsequent ascending infection.

URETERO-VAGINAL IMPLANTATION

Uretero-vaginal implantation has been employed on a few occasions, but as the operation results in a uretero-vaginal fistula, and probably hydronephrosis, it is not one to be recommended unless in exceptional circumstances.

URETERO-VESICAL ANASTOMOSIS

When the loss of substance has been too great to permit of uretero-ureteral anastomosis, grafting the end of the ureter into other parts has been resorted to. The most suitable one to employ is uretero-cystostomy, or implantation of the ureter into the bladder. Vesical grafting has been carried out in four different ways: (1) grafting the ureter into the bladder through the vagina; (2) grafting the ureter into the bladder by an extraperitoneal route, an incision being made through the abdominal wall for the purpose; (3) by an intraperitoneal operation; or (4) by dividing the vesico-vaginal septum and grafting the ureter into the bladder direct. The first operation, according to Bovee, was performed by Tuffier in 1877. The next operation was done by Novaro in 1893, and since that time eighty uretero-cystostomies have been performed. Of these, thirty-seven were resorted to on account of accidental wounding of the ureter in abdominal operations. In such cases anastomosis with the bladder should be established as soon as the accident is discovered.

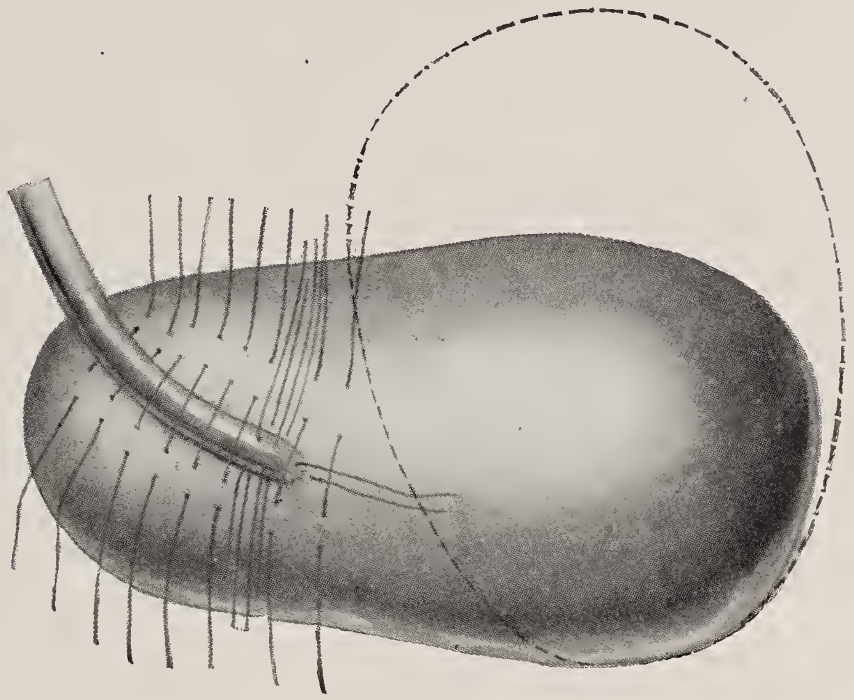

FIG. 304. URETERO-VESICAL ANASTOMOSIS. Method of suturing the bladder and ureter, so that when the sutures are tied the ureter is enveloped in a covering of the bladder-wall.

Operation. The cut end of the ureter should be split longitudinally for about 1/3 inch. An incision is then made obliquely through the wall of the bladder at the most convenient point, and a small sound introduced through the bladder is passed into the ureter. The cut end of the ureter is then pushed through the opening made in the bladder and carefully fixed by interrupted sutures through the wall of the bladder as indicated in Fig. 304. Retroperitoneal drainage should be established, and a catheter retained in the bladder for five or six days. This is the most satisfactory method of re-establishing something like the natural condition of matters, although it must be admitted there is a risk of stenosis being established; but when the end of the ureter is split before uniting it to the bladder the risk is considerably diminished.

END-TO-END AND LATERAL ANASTOMOSIS

These have been done in four different ways: (1) *The transverse end-to-end method* (see Fig. 305) was first performed by Schopf in 1886. Transverse wounds of the ureter tend to gape, and there is considerable danger of stenosis at the point of union, but the advantage of this method is that there is no loss to the length of the duct. This operation has been performed twelve times. (2) *The oblique end-to-end method* was devised by Bovee, and his patient was free from any symptoms referable to the urinary passages four years after the operation.

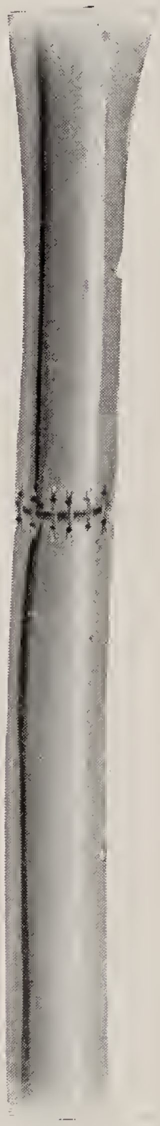

Fig. 305.
Transverse End-to-end Ureteral Anastomosis.

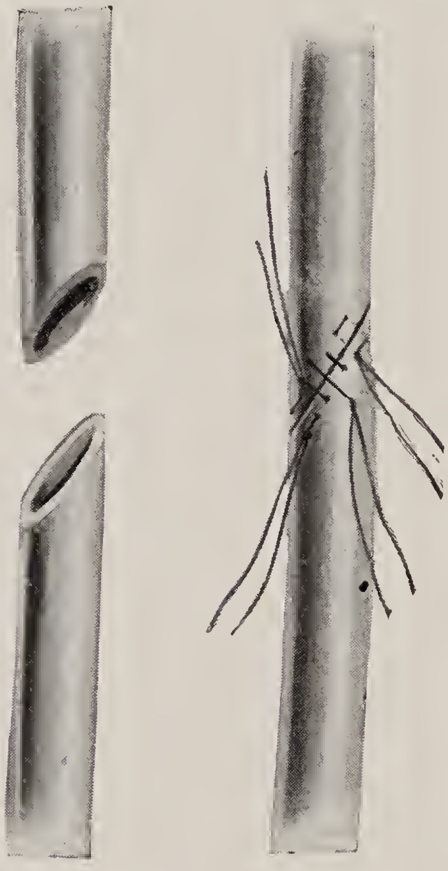

Fig. 306.
Oblique End-to-end Ureteral Anastomosis.
(*Bovee.*)

(3) *The end-in-end operation* devised by Poggi from experiments upon dogs has been very successful. In this method the upper segment of the duct is invaginated into the lower segment, and, if necessary, the latter is split for a short distance. It has been performed nine times with one death.

Bovee's *oblique end-to-end method* is a very satisfactory one. The ends of the ureters are cut obliquely before suturing, which is carried out as indicated in Fig. 306. This method prevents a circular scar, and so probably is less liable to contraction. The number of sutures inserted must be regulated by the conditions of the individual cases.

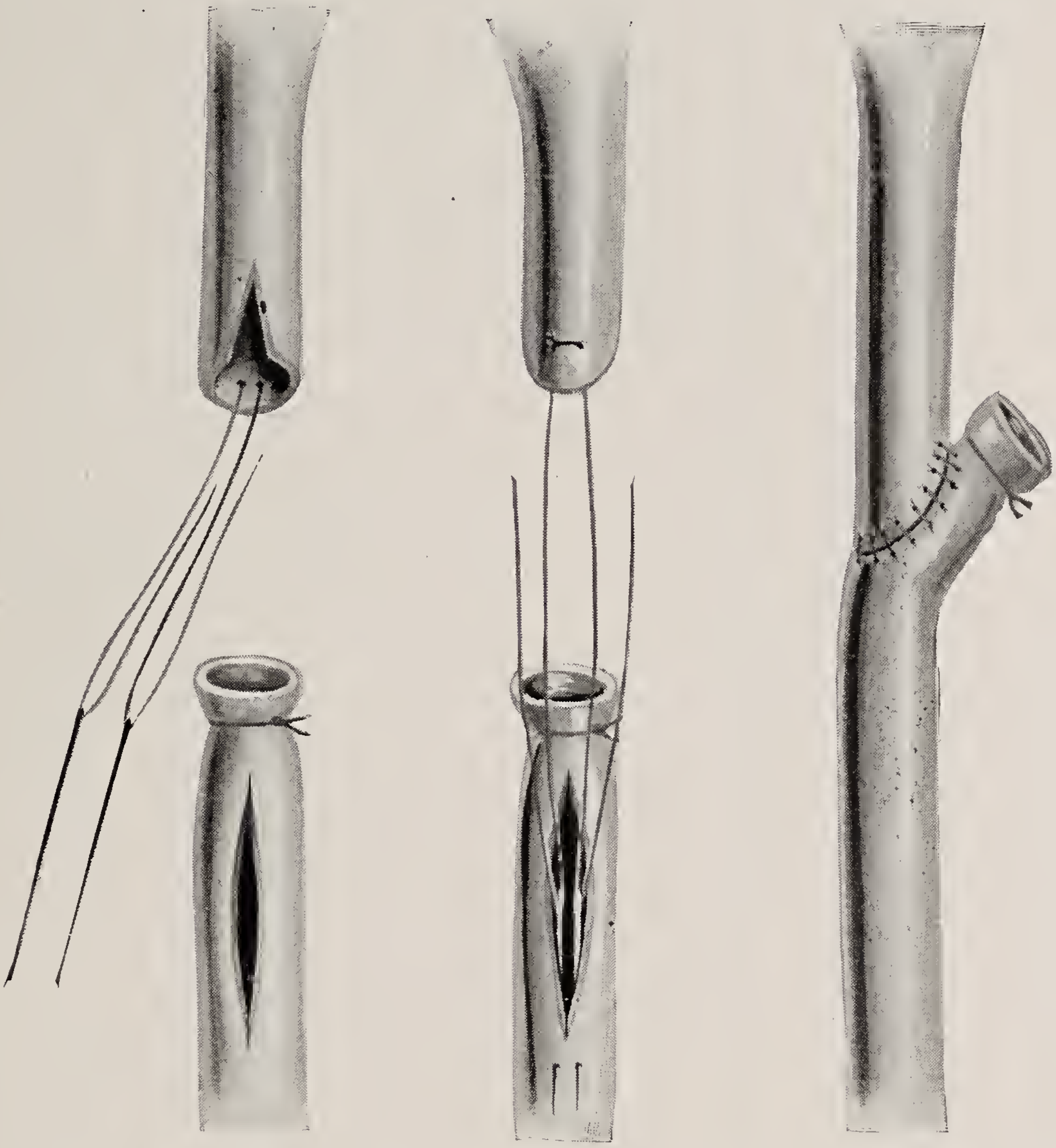

FIG. 307. VAN HOOK'S LATERAL IMPLANTATION OF THE URETER.

Van Hook's operation (see Fig. 307) of *lateral implantation* by invagination of the upper segment of the ureter into the side of the lower segment, and its retention by sutures, is most useful when there is undue lengthening of the ureter from stretching.

Van Hook's description of the operation is as follows:—

'Pass two very small cambric needles, armed with one thread of sterilized catgut, through the upper end of the ureter ⅛ inch from the extremity, from within downwards, the needles being from 1/16 to ⅛ inch apart, and equidistant from the end of the duct. These needles are now carried through the slit in the side of the lower end of the ureter, into and down the tube for ½ inch, when they are pushed through the wall of the duct side by side.'

By pulling upon the sutures the upper end of the cut ureter is drawn into the longitudinal slit in the side of the other segment. The three ends of the sutures are then knotted and the invaginated part of the duct is fixed. Half a dozen to eight sutures are then applied if necessary, and probably render van Hook's original operation more secure. If the operation be carried out intraperitoneally, a flap of peritoneum may be utilized in covering the ureteral wound. Whichever operation be employed, careful examination should make certain that the duct is permeable throughout, and an endeavour should be made to discover any congenital abnormality either of the duct or of the renal pelvis.

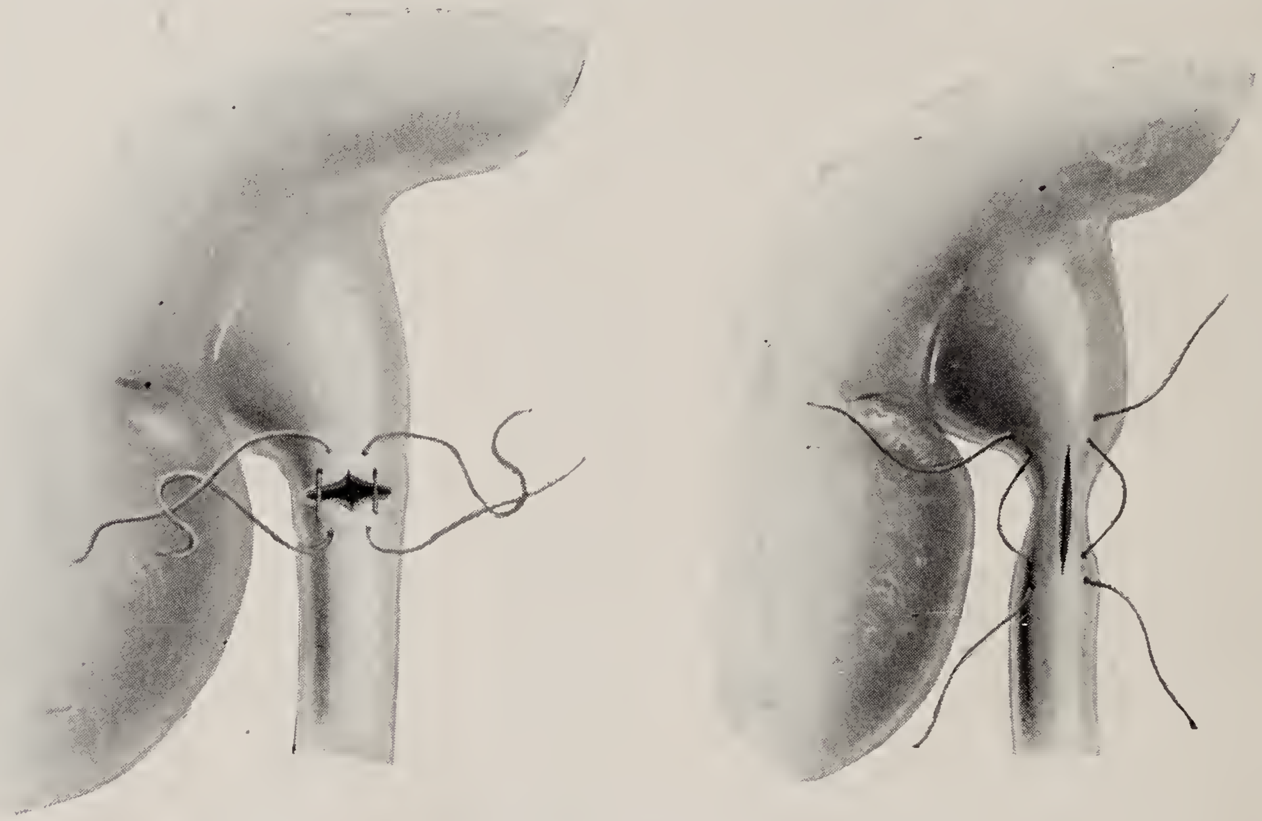

FIG. 308. URETEROPLASTY FOR STRICTURE.

In the event of the anastomosis being effected low down in the ureter, it is a wise precaution to retain a catheter in the bladder for a few days, in order to prevent any strain upon the canal, as not uncommonly the mouth of the ureter has lost its contractile power where anastomosis is demanded. Drainage of the wound should be secured by means of gauze and rubber tubing.

URETEROPLASTY

Operation for the relief of stricture of the ureter is not often called for, but the lumen of the duct may be increased by the following method:—

Operation. The duct having been opened above or below the stricture, a catheter is introduced, and on the line of the catheter a longitudinal incision is made about 2/3 inch in length. The cut edges are then united by catgut stitches running parallel to the lumen of the duct, as indicated in Fig. 308. In this way the length of the canal is slightly diminished, but its lumen at the point of stricture is increased. Such a method of operating is, however, only applicable when there is not much induration of the wall of the duct. When it is thickened and dense the stricture should be incised and an oblique end-to-end anastomosis carried out if circumstances permit.

The sutures best suited for operation upon the ureters are catgut, treated so as to remain unabsorbed for a fortnight, and where possible the Lembert method should be adopted.

SECTION VI

OPERATIONS UPON THE GENITO-URINARY ORGANS

PART II

OPERATIONS UPON THE BLADDER

BY

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CHAPTER VIII

CYSTOTOMY

The bladder may be opened above the pubes (suprapubic cystotomy) or from the perineum (perineal cystotomy).

PERINEAL CYSTOTOMY

Indications. Perineal cystotomy may be used for:

(i) *Exploration of the bladder.* This is very seldom performed by this route at the present day. With a perineum of ordinary depth only a small part of the finger can be introduced into the bladder, and although assistance may be obtained by placing the free hand on the suprapubic region and pressing the bladder down upon the exploring finger, the area of the bladder that is explored by this means is extremely limited. If the perineum be deep or if the prostate gland be enlarged and the finger of the operator short, no more than the finger-tip may reach the bladder.

(ii) *The extraction of foreign bodies and calculi* is sometimes very difficult by this route, and only small calculi can be removed. The advantages that suprapubic cystotomy presents over perineal cystotomy in these operations are the complete exposure of the whole of the cavity of the bladder to the finger, to instruments, and, if necessary, to the view of the surgeon, and the possibility of extending the wound so as to meet any contingency. The superiority of perineal cystotomy in regard to rapid healing of the wound no longer exists; for, where rapid healing is desirable, the suprapubic wound may be closed at the time of the operation.

(iii) *Perineal drainage of the bladder.* This is discussed later (see p. 630). Perineal cystotomy is most frequently used in cases of stricture of the urethra, with or without fistulæ, where cystitis is present, or where a stone in the prostatic urethra is complicated by stone in the bladder.

Operation. The patient should be carefully prepared by a vegetable aperient followed by an adequate dose of sulphate of magnesia, and, on the morning of the operation, by a large soap and water enema. The perineum is shaved and cleansed, a curved staff with a deep groove on the convexity of the curve is introduced into the bladder, and the patient is placed in the lithotomy position.

The staff is held vertically by an assistant standing on the left side of the patient above the level of the pelvis. The assistant grips the handle of the instrument with the right hand and includes the lowest part of the scrotum in his grasp. The thumb is held vertically against the roughened surface of the handle of the staff. The hand of the assistant inclines towards the abdomen so that the curve of the staff in the membranous urethra is pushed towards the perineum. The surgeon sits on a stool opposite the perineum. With a straight scalpel an incision 2 inches in length is made from above downwards in the middle

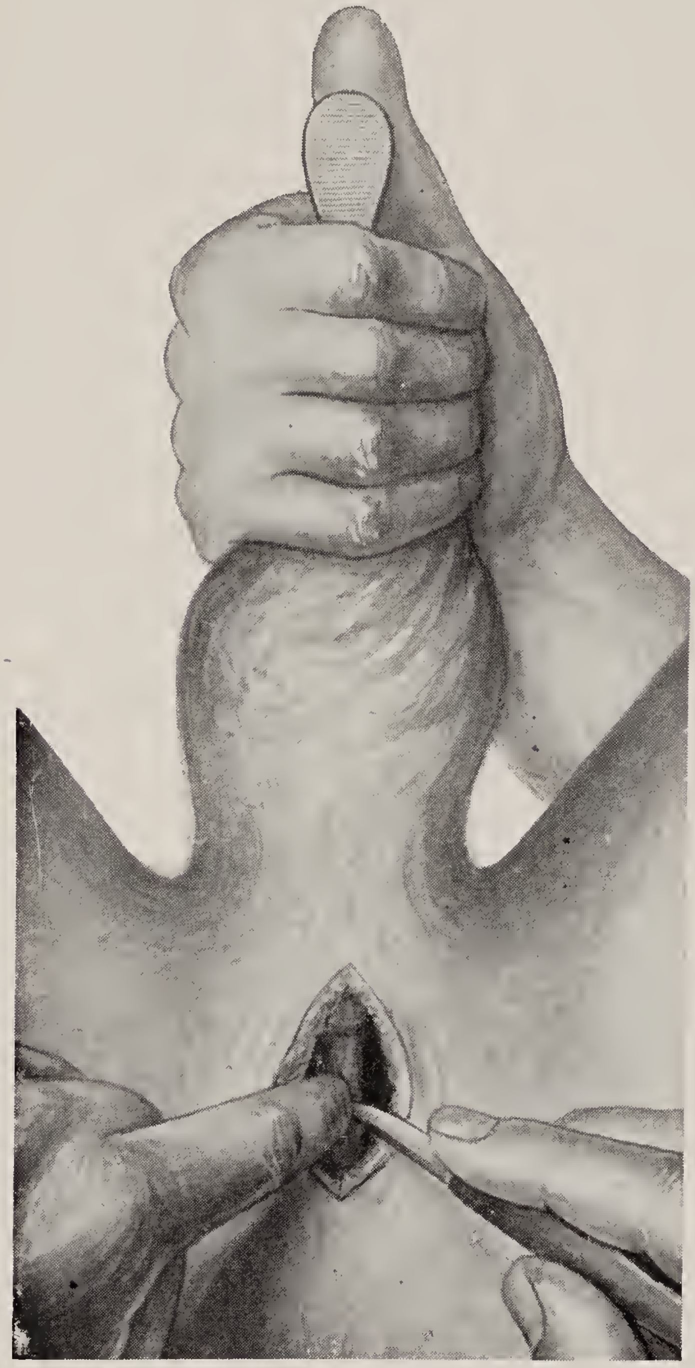

FIG. 309. PERINEAL CYSTOTOMY. *First stage.* The tip of the left forefinger is directing the point of the knife into the groove in the staff in the membranous urethra.

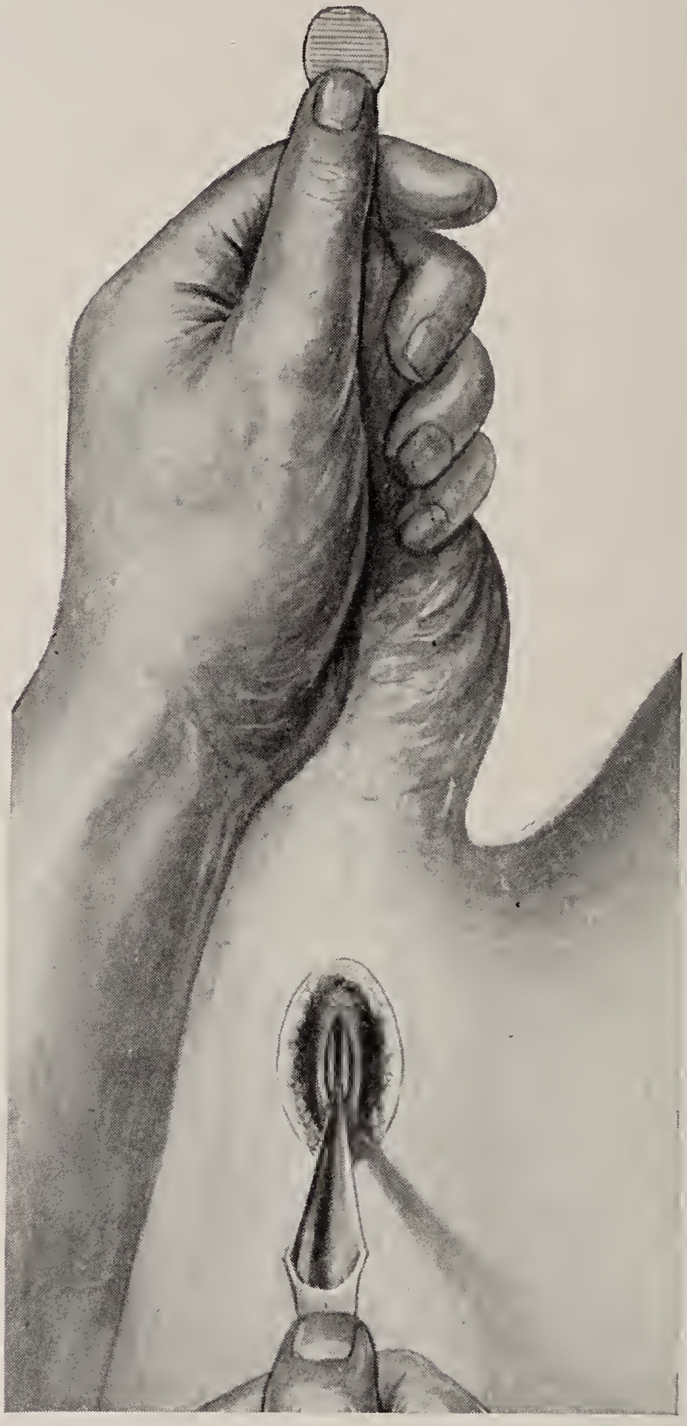

FIG. 310. PERINEAL CYSTOTOMY. *Second stage.* The point of the gorget has been placed in the groove of the staff, which is being depressed towards the perineum by the operator's left hand.

line of the perineum, ending ½ inch in front of the anus. This is deepened and the bulb is seen at the upper part of the wound. The staff is now made prominent in the membranous urethra by depressing the handle towards the abdomen, and the left forefinger of the operator seeks the groove on its convexity (see Fig. 309). The point of the knife is directed into the groove and the knife is pushed along horizontally until the blade is in the prostatic urethra. The membranous urethra is thus opened along its posterior wall and the commencement of the prostatic urethra notched. The knife is now withdrawn, still keeping the blade horizontal. A probe-pointed gorget or a Little's grooved director is introduced into the wound and pushed along the groove, while the surgeon takes the handle of the staff from the assistant with his left hand and raises it into a more vertical position, and as the gorget passes inwards and upwards, depresses it towards the perineum (see Fig. 310). A gush of urine shows that the gorget has entered the bladder. The staff is now withdrawn, leaving the gorget in position, and the forefinger of the left hand is introduced along the

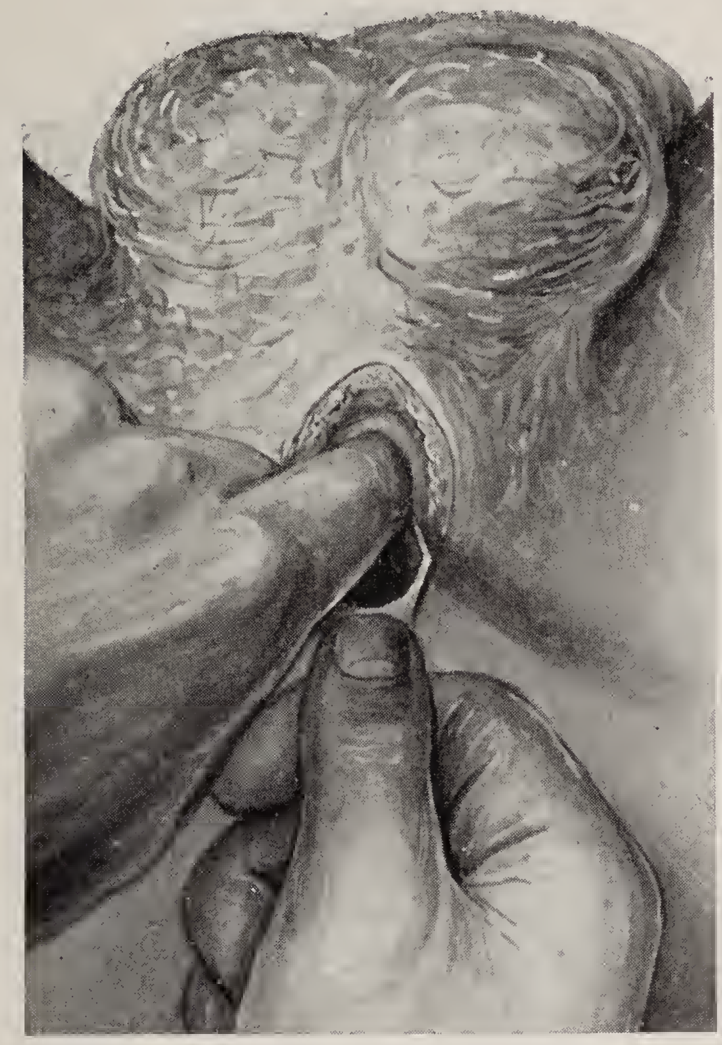

FIG. 311. PERINEAL CYSTOTOMY. *Third stage.* Introduction of the forefinger along the gorget into the bladder.

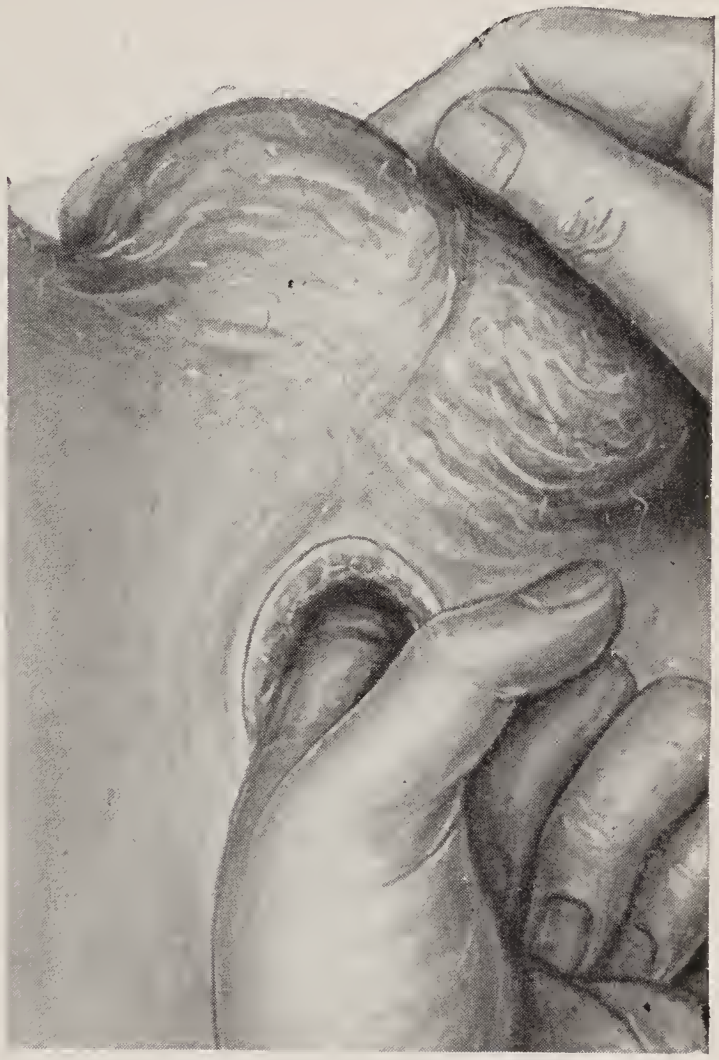

FIG. 312. PERINEAL CYSTOTOMY. *Fourth stage.* Exploration of the bladder with the left forefinger, and counter-pressure above the pubes.

gorget (see Fig. 311). The entrance to the bladder, with the patient in this position, lies well up behind the pubes, and is narrow and resistant. The finger must be pushed through it by a screwing movement. If the object of the operation is exploration of the bladder, the finger is pushed as far as possible through the sphincter, and the surgeon, turning the left-hand palm upwards, rises and presses the disengaged right hand on the suprapubic region, pushing the bladder downwards (see Fig. 312). The fluid should be allowed to escape from the bladder so that as much as possible of the wall can be reached by the finger.

If drainage be necessary the gorget is again slipped into the bladder and the finger withdrawn. A large rubber drainage tube (see Perineal Drainage) is guided along this into the bladder.

SUPRAPUBIC CYSTOTOMY

Indications. This operation is the first stage of the various methods that will be described in the following pages for the drainage of the bladder, removal of stone and foreign bodies, the removal of growths, and the treatment of ulceration of the bladder and operations upon the prostate.

Operation. The pubes having previously been shaved and the suprapubic region prepared for operation, the patient is anæsthetized. A catheter is passed and the bladder distended with 12 ounces of warm boric lotion by means of a bladder syringe. If the urine be foul, the bladder should be filled and emptied repeatedly until the washing returns clear before the final distension. The catheter is left in the urethra, and the open end plugged with the nozzle of a full syringe which lies upon a towel placed across the patient's thighs. Over this sterilized towels are arranged which leave an uncovered space in the suprapubic region. The surgeon stands on the left side of the patient with an assistant opposite him and a second assistant, if such be available, at his left hand.

An incision, 2½ inches in length, is made in the middle line, commencing just below the upper border of the symphysis pubis and passing upwards. In a stout individual the incision through the skin and subcutaneous fat must be longer, but the deeper part of the wound does not exceed this size.

A vertical incision is preferable in the majority of cases, and it need seldom exceed 3 inches in length. In stout patients and in cases where the peritoneum is to be opened for any reason the wound may be extended. The incision here recommended will suffice for the most extensive intravesical operations. An objection to the vertical incision is that the recti prevent the full exposure of the front wall of the bladder. These muscles are usually lax under anæsthesia, but occasionally there is a spasmodic rigidity of the muscles which is not abolished by deep anæsthesia. In such cases spinal analgesia is of service. More room may be obtained by incising the edge of the rectus on either side.

The operator holds aside the skin and subcutaneous tissue with the parted fore and second fingers of the left hand (see Fig. 313) and the anterior layer of the rectus sheath is exposed. This is cleanly cut through in the middle line. The pyramidalis and recti muscles now come into view. No time need be lost in seeking for a median partition between the muscles in this position. If it exists it is seldom seen and is of no importance. With the handle of the scalpel the longitudinal muscle bundles are separated in the middle line, taking care to make only one track between the coarse bundles. The knife is now laid aside, and the forefinger is introduced between the separated layers of muscle and seeks the upper limit of the symphysis pubis. Having found this the distended bladder can be felt behind it. The finger is now pressed directly backwards towards the surface of the bladder and the point of it hooked upwards. In doing this the layer of fascia transversalis behind the recti will be torn through, or the muscles may be retracted and this layer deliberately incised in the median line. The prevesical fat and the pocket of peritoneum which dips in front of the bladder are thus exposed. These are displaced upwards by a stroking movement of the finger, which at the same time hooks them up from the bladder-

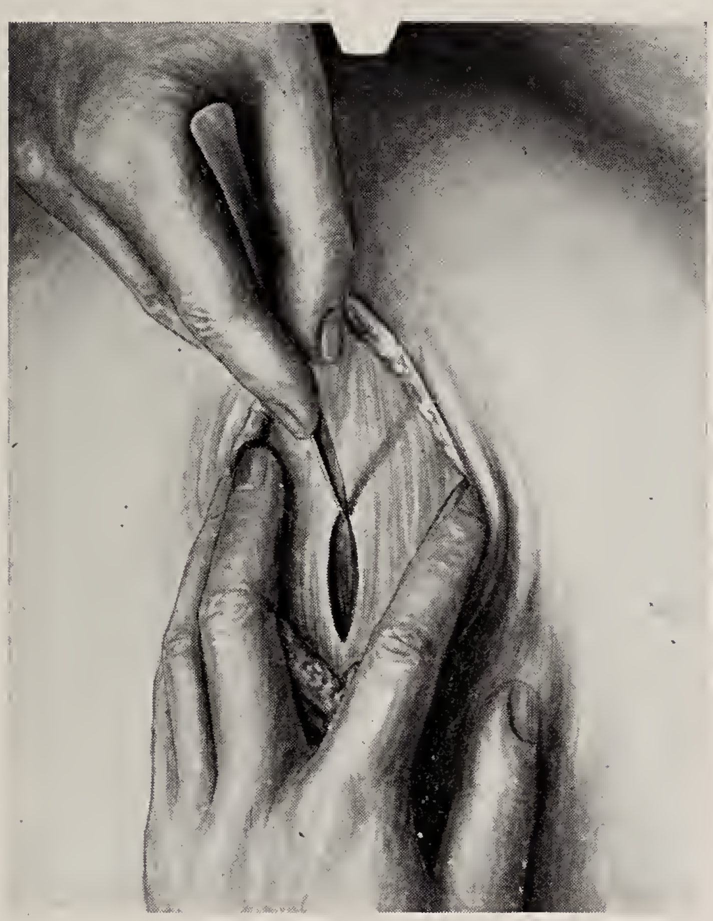

FIG. 313. SUPRAPUBIC CYSTOTOMY.
Incision of the rectus sheath.

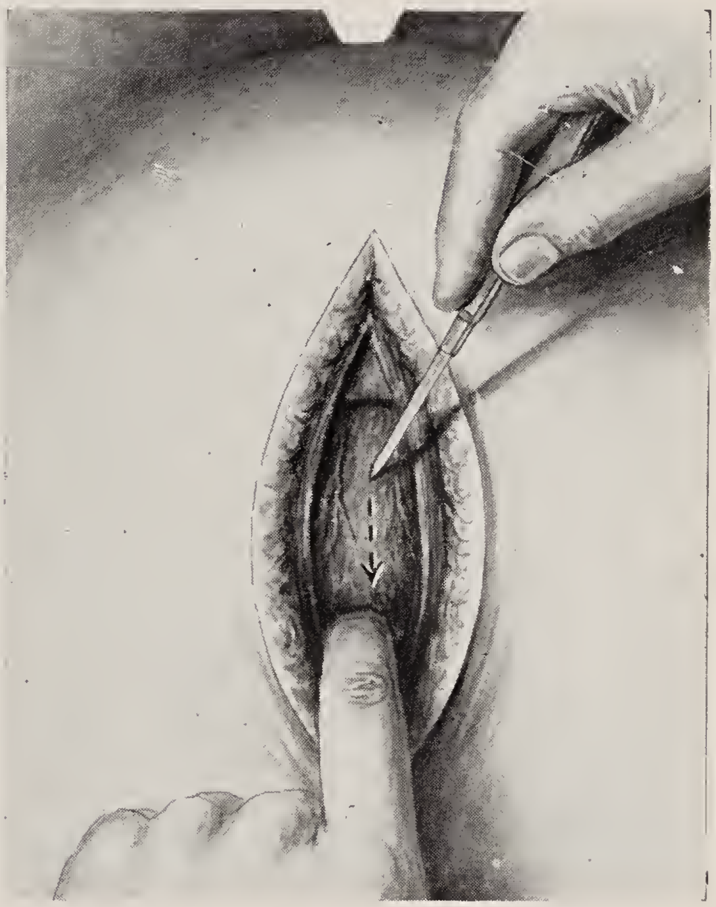

FIG. 314. SUPRAPUBIC CYSTOTOMY.
Incising the bladder-wall.

wall. At this time the second assistant should uncover the full syringe which plugs the catheter and gently increase the distension of the bladder. The surgeon holds aside the fat and peritoneum at the upper extremity of the wound with his left forefinger and makes certain that the bladder-wall is exposed. This is recognized by the muscle fibres and the presence of large veins coursing longitudinally on its surface and also by the firm elastic sensation it imparts to the finger. If a pocket of peritoneum covers it, the respiratory movements causing the abdominal contents to advance and recede will be plainly evident.

If any doubt exists in the mind of the operator, retractors may be placed to draw the recti muscles on either side and the anterior wall of the bladder fully exposed and viewed by the aid of a head-lamp. The bladder can now be felt as a fluid cushion. A scalpel held vertically a little above the pubic symphysis, with the cutting edge away from it, is plunged through the anterior bladder-wall with a stabbing movement (see Fig. 314). This puncture must be made boldly so as to avoid pushing the bladder mucous membrane before the knife. In withdrawing the knife the incision is extended a little upwards. The distending fluid wells up from the wound, the knife is quickly laid aside, and the right forefinger is inserted into the bladder wound and hooks up the wall before the bladder has time to collapse. Some surgeons recommend the use of a sharp hook to steady the bladder-wall while the incision is being made. This is introduced transversely in the middle line near the upper part of the exposed bladder-wall. The finger may now be replaced by a retractor which holds up the upper angle of the bladder wound in the middle line. The further procedure depends upon the object for which the cystotomy was performed.

Certain points in connexion with the technique of the operation will now be discussed.

Distension of the rectum. This method is very seldom employed at the present day, as it has been found that with it the elevation of the bladder base is not always sufficient to be of assistance, and the part of the anterior bladder-wall uncovered by peritoneum is not materially increased. Moreover, cases have been recorded in which rupture of the bowel followed over-distension of the bag.

Distension of the bladder. The capacity of a bladder is influenced by age and disease. In children 5 or 6 ounces may fully distend the bladder. In an adult male or female 10 or 12 ounces will give a moderate distension if the bladder be not contracted. This is the quantity which is borne with comfort in a conscious patient, and with this amount the bladder is full but not over-distended. A catheter in the urethra held erect and open will not discharge the fluid. The intravesical tension with this amount of fluid is therefore low. With an irritable bladder a less amount may be sufficient to cause vesical spasm, and the whole may be ejected, and sometimes the catheter may also be discharged from the urethra by the violence of the spasm. Spasm may be aroused by too rapid and forcible injection of the fluid and by use of fluid that is too cold. Care must therefore be taken that the bladder is distended gradually, and that the temperature of the fluid is 108° F. Under an anæsthetic more fluid may be injected into the bladder, and even where the fluid has been spasmodically ejected several ounces may eventually be retained where patience is exercised. When there is difficulty in retaining the fluid in the bladder a turn of bandage may be placed round the penis, or an elastic band over a layer of lint; but this is seldom necessary, and the method of plugging the catheter with a full syringe and increasing the fluid in the bladder after that viscus is exposed has much to recommend it. Over-distension of the bladder, especially where inflammation is present, may rouse the patient from a deep anæsthesia.

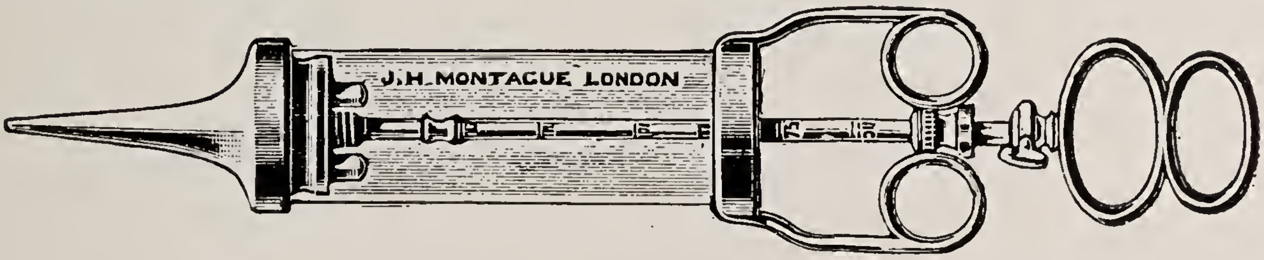

FIG. 315. BLADDER SYRINGE.

An atonic bladder will hold a pint or more without the intravesical tension being sufficiently increased to raise the fluid 6 inches in an open catheter. This is frequently observed in patients suffering from enlarged prostate. It is unnecessary to introduce more than 15 ounces before the bladder has been exposed, even in these cases.

The syringe must run smoothly and easily, for by means of the pressure which is exerted on the piston an idea of the intravesical tension should be gained. The best syringes have a stout glass barrel and an asbestos piston, and hold from 4½ to 5½ ounces of fluid (see Fig. 315). A solution of boric acid at a temperature of 108° F. is the most suitable medium, or solutions of oxycyanide of mercury (1 in 10,000) or biniodide of mercury (1 in 10,000) may be used.

The advantages that have been urged in favour of air-distension of the bladder are mainly theoretical. The danger of septic inflammation from the soaking of the wound with fluid used to distend the bladder is slight when the bladder has been carefully washed before commencing the operation and when proper attention is given to the wound by daily lavage after the operation. The buoyancy of air is not required, even if it have the effect of raising the bladder to the abdominal wall with which it is credited. The approach to the bladder is quite simple when fluid is used. Neither air nor fluid should be introduced into the bladder under such pressure as will give the more compressible air any advantage over the less compressible fluid.

Cystotomy without distension of the bladder is necessary in some cases, such as vesico-vaginal fistula. If it be possible to pass a sound through the urethra this should be pushed well into the bladder. Especial care is necessary after incising the abdominal wall, to avoid wounding the peritoneum. The point of the sound in the collapsed organ provides a ready guide on which an incision is made. When the instrument is exposed the edges of the bladder wound are held up with catch-forceps and the wound extended with scissors. Von Dittel, who was the first to suggest this method, used a fully curved Bénique's sound. If no instrument can be passed into the urethra the operation is more difficult. The skin and recti muscles should be widely retracted and the bladder exposed with the aid of a powerful head-lamp, taking care to identify the peritoneum and dissect it up before opening the bladder.

The after-treatment of the wound. When the object of cystotomy has been attained, the question of treatment of the wound in the bladder-wall will arise. In some cases it is possible to close the wound by immediate suture, in other cases temporary drainage will be adopted, and in others permanent drainage must be installed.

Immediate suture is the ideal method of treatment, but is not always expedient. The following factors contra-indicate its use:—

Obstruction. After opening the bladder in a case of obstruction, it may be found impossible to remove the cause of the obstruction (malignant disease of the prostate). In such a case an attempt to close the bladder wound usually fails. Permanent suprapubic drainage will probably be necessary. On the other hand, it may be possible to remove the obstruction but inexpedient to proceed to the radical operation at once. Thus, in some cases of simple enlargement of the prostate, temporary drainage is indicated preparatory to the radical operation.

Sepsis. When cystitis exists, or when septic changes are present in the kidneys, immediate suture of the bladder is unwise. Obstruction and sepsis frequently combine to contra-indicate immediate suture.

Hæmorrhage. After the removal of bladder growths it is wise to place a drain in the bladder, unless the surgeon is convinced that all bleeding has ceased, and if oozing be still proceeding this is imperative. A small drainage tube or two tubes of small calibre are insufficient, for they quickly become blocked with clot, and a catheter tied in the urethra is equally ineffectual. When the patient has been in the Trendelenburg position some minutes must be given, after replacing him in the horizontal position, for the circulation to readjust itself before concluding that no hæmorrhage will take place.

After removal of the prostate by the suprapubic route, free drainage of the bladder is imperative on account of one or more of these contra-indications.

The cases most favourable for immediate closure of the bladder wound are cases of cystotomy performed for aseptic calculi or for foreign bodies, and cases of operation for papillomata where the bleeding has been effectually controlled. To these might be added exploration of an aseptic bladder, but cystoscopy has replaced cystotomy in these cases.

If the edges of the bladder wound have been anchored by means of stitches, these are pulled up so that the bladder is brought into the abdominal wound. If no retaining sutures have been used, each lip of the wound is grasped at the middle with a pair of toothed forceps. The edges of the abdominal wound are well retracted. Interrupted catgut sutures are used, and pierce the perivesical tissues and the bladder muscle on each side, but do not penetrate the mucous membrane. The mucous membrane is loosely attached to the muscle and is easily avoided. The sutures should be closely set, about four to the inch, and commence at the apical end of the bladder wound. The first suture is placed a little above this end of the wound in Lembert fashion and tied. The remaining sutures pierce the edges of the wound, and each is tied after insertion and held up by an assistant. By this means gentle traction is exerted upon the bladder, so that the lower part of the wound gradually comes into view. Six or eight sutures may be required, and full curved medium-sized needles are employed.

When the bladder-wall is thin it may be necessary to pass mattress sutures, inserting the needle parallel with the wound, upwards on one side and downwards on the other, so as to get a good grip of the thin muscle. Some surgeons insert a row of Lembert's sutures over this first row of sutures.

Buried sutures of stout catgut are inserted in the abdominal wound by means of large curved needles. In these should be included the fascia transversalis, a thick bundle of rectus muscle, and the strong fascia in front of the rectus. Three or four of these sutures will be required, and a small calibre drainage tube is placed in the lower angle of the wound and reaches down to the closed vesical wound. This is removed in thirty-six hours if the wound remains dry. It should not be retained longer than two or three days, even if a little urine has leaked out. The skin is closed by interrupted silkworm-gut sutures.

The careful closure of the abdominal portion of the wound, whether a small tube be placed at its lower angle to drain the prevesical space or whether the bladder be drained by a large rubber tube, is a matter of supreme importance, since neglect of this precaution is likely to be followed by a hernial protrusion of the peritoneum at the upper part of the wound.

If proper drainage of the bladder and prevesical space be provided by means of tubes of suitable size there is no need to fear cellulitis even in septic cases.

After-treatment. Where the bladder wound has been closed in the manner above described, a silk-wove coudé catheter (No. 22 F.) is tied in the urethra and retained for four days. During this time the urine is allowed to drain continuously into a bottle between the patient's thighs. A careful watch is kept to prevent the catheter becoming blocked with clot. Should this occur a syringeful of boric lotion should be injected to clear the lumen.

If copious bleeding and intravesical clotting occurs, the catheter will be useless. In these cases the bladder usually fills up with clot, so that it can be felt above the pubes. It is wise in such a case to reopen the suprapubic wound without delay, clear out the clots, irrigate the bladder through the catheter with a copious stream of hot boric lotion, and place a large drainage tube in the bladder wound. The catheter may then be removed.

Should no such accident have occurred, the catheter is retained for four days and then removed. The patient is then directed to pass water without straining every two hours, and is wakened once or twice during the night so as to prevent the bladder being over-distended. At the end of a week no restriction need be placed upon micturition and the wound should be healed. Occasionally a slight leak occurs and continues for a week or ten days and then ceases.

The indications for bladder drainage and the methods by which it is carried out are considered on p. 630.

Difficulties and dangers. *Wounds of the peritoneum.* The peritoneum may be inadvertently opened when the bladder-wall is incised. This is usually due to want of care in freeing the prevesical pouch of peritoneum and pushing it up out of the way. Sometimes in inflammatory conditions of the bladder with pericystitis and in secondary operations upon the bladder the peritoneum is actually bound down to the front wall of the bladder. If this be recognized the membrane should be dissected up, but it may escape notice and the incision may cut through the peritoneum as well as the bladder. The opening is usually plugged by omentum, and the appearance of a piece of omentum may be the first intimation that the peritoneum has been wounded. Occasionally the incision in the bladder wall is correctly made, but the wound is torn open by the drag of retractors or fingers and a rent made in an adherent peritoneum.

When it is recognized that the peritoneum has been incised or torn, the opening should be utilized to define exactly the lower limits of the pouch, and with the finger in the pouch the peritoneum should be dissected off the face of the bladder. Any excess of fluid at the opening should be mopped up, but no extensive disturbance of the viscera is necessary or advisable. The ends of the rent are picked up in catch-forceps and the wound closed by continuous or interrupted catgut sutures. In most cases the operation may be proceeded with, but if the urine is foul it will be wiser to place a large drain in the bladder, and postpone further interference.

Hæmorrhage. There is usually very little hæmorrhage during the operation of suprapubic cystotomy. Occasionally a vein in the bladder-wall bleeds, but this quickly ceases when the bladder collapses. An artery may be cut in the bladder-wall and require to be picked up with forceps. I was asked to see an unusual case of hæmorrhage in a patient on whom a colleague had performed cystotomy preparatory to prostatectomy. A general oozing from the bladder-wall and surrounding tissues commenced after the operation and resisted all local and general measures, and the patient died from loss of blood. There had been no signs of hæmophilia.

MODIFICATIONS OF SUPRAPUBIC CYSTOTOMY

Transverse suprapubic cystotomy. So long ago as 1730 Ledran [1] suggested the use of a transverse incision, but it was not until Trendelenburg [2] combined the transverse incision with the inclined position of the patient that the method became widely known.

Operation. The bladder is distended with fluid and the patient placed in the Trendelenburg position. The surgeon stands on the left side of the patient with an assistant opposite him. A transverse incision from 6 to 8 inches in length, according to the build of the patient, is made across the lower part of the abdomen. The incision is curved, with its concavity towards the umbilicus. In the middle line it lies 1 inch above the upper border of the pubic symphysis and at either extremity 2 inches above Poupart's ligament. The incision is deepened through the subcutaneous tissues and deep fascia to the sheath of the recti muscles. The sheath is cut through in the line of the incision

[1] *Manuel des différentes manières de tirer la pierre hors de la vessie,* 1730.

[2] *Berl. klin. Wochenschr.,* 1877.

and the recti and pyramidales muscles exposed. These muscles are cut through transversely. The recti muscles retract upwards, and some difficulty may be experienced in bringing them down when the surgeon comes to close the wound. It is advisable, therefore, before completely cutting through the recti muscles, to introduce one or two temporary sutures through the whole thickness of the muscles and sheath near the cut edge and clamp these with pressure forceps, using them for retraction during the operation, and for dragging down the muscles and sheath when the wound is being closed. The fascia transversalis beneath the muscles is cut through and the peritoneum exposed. The peritoneum is stripped off the front of the bladder and held aside with a broad retractor. The bladder is now very fully exposed and the reflection of the peritoneum on each side defined. A transverse incision is made through the wall of the viscus about the level of the upper border of the pubic symphysis. Higher up the bladder narrows towards its apex, and the incision would have to be more limited. When the bladder is opened precautions are taken to divert the fluid which escapes into a basin held at the side. The edges of the bladder wound are now picked up with toothed forceps, or several temporary sutures are introduced and the lips of the wound held aside. Instead of incising the bladder transversely, the incision may be made at any part of the wall and in any direction. Thus in removing a growth from the bladder the incision is placed so that the resection of the wall may be conveniently carried out.

The object for which the cystotomy has been performed having been accomplished, the surgeon will proceed to close the bladder wound and repair the abdominal wall. If no vesical drain be necessary, a continuous suture of catgut is made to close the wound in the bladder-wall. The stitches pass through the muscular coat without penetrating the mucous membrane. Over this a second row of Lembert's sutures of the same material is introduced. If drainage of the bladder be desired, a deep layer of interrupted sutures is used and reinforced by a second layer of Lembert's sutures.

The repair of the abdominal wall should be carefully performed. The patient is lowered into the horizontal position. The recti muscles and sheath of fascia are drawn down by means of the temporary sutures, and interrupted sutures of thick catgut are passed through the portion of recti muscles and sheath which remains attached to the pubic bones below and the free recti muscles and sheath above. Mattress sutures may be used, and one or two such sutures are useful towards the middle line, with ordinary interrupted sutures on each side. If bladder drainage has been adopted, room should be left for the tube and a second smaller tube should be placed in the prevesical space. The skin wound is now closed with silkworm-gut sutures.

The advantage of the transverse incision is the free access which is gained to all parts of the bladder. The disadvantage is the damage which is inflicted on the abdominal wall. By careful suturing this disadvantage is reduced to a minimum, but for most operations inside the bladder the vertical incision gives sufficient exposure. For extensive operations upon the bladder-wall for the removal of growths the transverse invision is a valuable method.

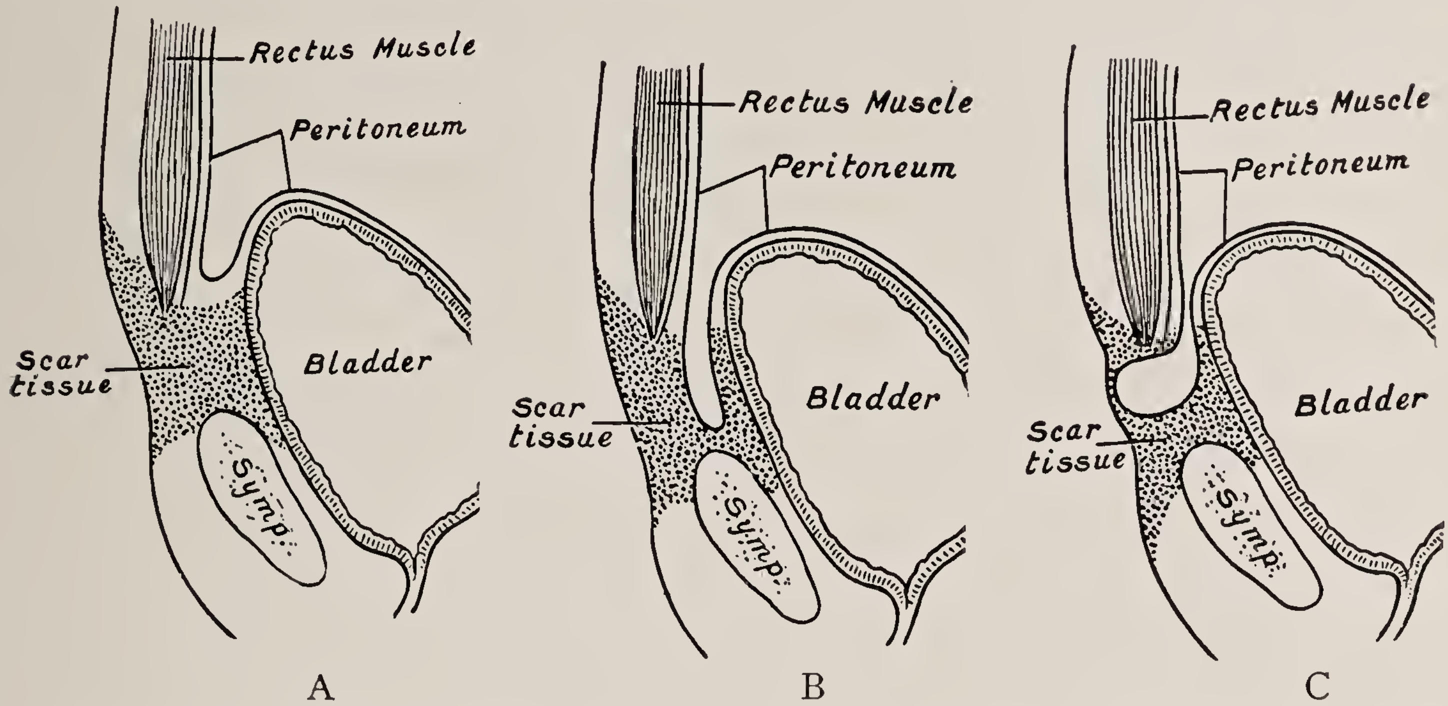

Fig. 316. The Conditions modifying a Secondary Cystotomy. a, The relation of the peritoneum to the scar and the bladder; b, A peritoneal process in the scar; c, Hernia of the scar.

Secondary cystotomy. Where cystotomy has been performed on some previous occasion, the following conditions may modify a second cystotomy: A small supple suprapubic scar which on dissection leads down between the recti muscles to the anterior wall of the bladder. The peritoneum is not involved in the scar (see Fig. 316, a). More extensive scarring may be present where there has been prolonged bladder drainage or widespread inflammation after the previous cystotomy. In these cases a pocket of peritoneum is frequently dragged down and fixed in front of the bladder, and is held down to the upper border of the pubic symphysis by fibrous tissue (see Fig. 316, b). Or a portion, usually at the upper end, of the scar is weak and a small pocket of peritoneum projects, covered by a thin layer of fibrous tissue (see Fig. 316, c). The bladder is frequently bound down to the posterior aspect of the pubic bones.

When no protrusion of the wound is apparent, the whole scar should be removed by an elliptical incision vertically placed. By deepening the wound on either side the rectus sheath is exposed, and the scar should be removed at this level. The dissection should be carried carefully between the recti muscles, keeping well down to the upper border of the pubic symphysis until the finger can be passed behind the recti muscles. The wound is then extended upwards in the middle line, freeing the fibrous tissue by transverse cutting and pushing it upwards with the finger. By this means a pocket of peritoneum bound down to the upper border of the symphysis will be freed and pushed into the upper part of the wound out of the way. The peritoneum may still be adherent to the upper part of the anterior wall of the bladder. In order to expose the bladder muscle careful dissection and free retraction are required. Should intravesical manipulation be necessary, as it will be in the removal of growths of the bladder, it is usually necessary to dissect the bladder-wall from the firm adhesions which bind it to the posterior surface of the pubes. A large steel sound passed through the urethra with the handle well depressed will be of much assistance in these operations.

When a hernia of the scar is present the scar may be excised together with the pocket of peritoneum, the peritoneum stripped upwards off the bladder, and the peritoneal surfaces brought together with a continuous suture. When the operation is being performed for growth, the opening in the peritoneum may be used to obtain information in regard to its extent, or it may be necessary for the further steps of the operation if they involve the peritoneal surface of the bladder. When the operation is confined to cystotomy or the further steps are extraperitoneal, the bladder may be opened, after closing the peritoneal wound with a continuous catgut suture and tucking a roll of gauze into the upper part of the wound. A transverse incision is preferable to the vertical incision in many cases of secondary cystotomy, and especially when an extensive intravesical operation is proposed.

Suprapubic cystotomy with resection of the pubic bones. In order to gain free access to the lower part of the anterior wall of the bladder some surgeons have resected portions or the whole of the pubic bones. Bramann[1] performed a temporary resection of a portion of the pubic bones. He makes a rectangular incision with the vertical portion in the middle line and the horizontal portion over the symphysis. With bone forceps and chisel the bone is divided obliquely on each side, commencing outside the spine of the pubes and passing down and inwards, and these incisions are joined by a transverse section of the bones. The fragment is separated from below upwards and carries the insertion of the recti muscles. The bone fragment is divided in the middle line and the right and left recti muscles separated, each carrying a fragment. The anterior wall of the bladder is thus exposed. After the operation the fragments are fixed to the body of the pubis by means of tacks.

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[1] *Deutsche Zeitschr. f. Chirurgie,* 1891.

Complete resection of the pubic bones was described by Ollier.[1] In order to preserve the vitality of the separated bone it is allowed to remain attached to the tissues at the root of the penis. An incision the shape of an inverted U is made through the skin with the convexity of the U 1 or 2 inches above the upper border of the pubes, and a vertical incision meets this in the middle line. The muscles are separated from the upper border of the pubic bones. The bone is cut on each side with a small saw and bone forceps. When the section is complete the whole flap is turned downwards and the front of the bladder exposed, taking care not to wound the retropubic venous plexus. After the operation the flap is replaced.

Suprapubic cystotomy combined with symphysiotomy. This operation was described by Tuffier and by Albarran[2] in 1892. A median vertical incision commencing 2½ inches above the upper border of the pubic bones is carried down to the root of the penis, and this is continued for half an inch on to the dorsum of the penis, and on each side for about an inch, forming an inverted Y incision.

The incision is deepened to the sheath of the recti muscles and the suspensory ligament of the penis cut through. The penis is now turned down and the lower border of the symphysis defined with the finger. The fibrous structures are incised down to the symphysis.

The recti muscles are separated, the prevesical fat exposed, and the peritoneum pushed upwards out of the way. A retractor is inserted into the space of Retzius and another drags down and protects the tissues of the penis. The symphysis is cut through with a strong scalpel exactly in the middle line from before backwards and from above downwards. The subpubic ligament is then carefully cut, avoiding the venous plexus of Santorini and the dorsal vein of the penis. A separation of 1½ to 2 inches may be produced without damage to the sacro-iliac synchondrosis. Having finished the operation upon the bladder, the cartilage of the symphysis is removed and the spongy tissue of the pubic bones exposed so as to obtain firm bony union. If the separation of the bones be moderate, the soft parts only need be sutured, but if it be considerable two sutures of silver wire are passed through the bones and the prepared surfaces thus brought into contact. A drain is placed behind the pubic bones and the suprapubic portion of the wound united as in the ordinary operation. In addition to the usual dressings, a stout binder surrounds the bony pelvis and prevents any movement of the iliac bones.

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[1] Rochet, *Chirurgie de l'urètre, de la vessie, de la prostate,* Paris, 1895.

[2] *Médecine opératoire des voies urinaires,* 1909.

By means of symphysiotomy a very free access is obtained to the lower part of the anterior wall of the bladder. The shock of the operation is, however, considerably greater than that of suprapubic cystotomy by the ordinary method. Albarran, who has used the method four times, believes that it is rarely necessary.

BLADDER DRAINAGE

Indications. Drainage of the bladder may be required as a temporary measure after operations upon the urethra or bladder or as a means of treatment of some cases of cystitis. Permanent drainage of the bladder may be necessary in cases of malignant disease of the prostate or bladder.

PERINEAL DRAINAGE

Where cystitis complicates a urethral or prostatic disease for which a perineal operation is performed, the bladder may be drained by the introduction of a perineal tube.

The best form of drain is a flexible rubber tube with a terminal opening and lateral eyes (see Fig. 418, p. 779). The edges of the opening are smooth and rounded. This tube is introduced just through the vesical sphincter, and its position tested by injecting a syringeful of lotion into the bladder and withdrawing the tube until it ceases to flow, and then pushing it on until the flow recommences. A silkworm-gut suture is passed through each lip of the perineal wound and through the tube and holds it firmly in position.

Another form of tube is a stiff gum-elastic tube with a large terminal and fine lateral opening at the vesical end and a metal ring with lateral eyes at the outer end. The tube is retained in position by passing a length of tape through each eye and carrying it along the fold of the groin in front and the fold of the buttock behind. The tapes are knotted on each side above the great trochanter, and attached to a waist-belt above this. To these perineal tubes may be attached a short length of rubber tubing, which lies in a urine bottle between the patient's thighs, or a longer tube may be attached which passes into a receptacle containing antiseptic fluid beneath the bed. The tubing is fixed at the edge of the bed by means of a loop of tape and a safety-pin, and a short glass tube interrupts the rubber tube at some point so that the flow of urine may be observed.

Drainage by this method may be maintained for four to seven days, and if it is desired to prolong it beyond this time a soft rubber tube should replace the rigid one. The perineal route is not, however, suitable for permanent drainage.

TEMPORARY SUPRAPUBIC DRAINAGE

Temporary suprapubic drainage is practised after the majority of suprapubic operations (see p. 622).

For this purpose a double tube of moderate calibre, curved at a right angle (Guyon's double siphon), may be inserted into the bladder wound, which is closed by a few catgut stitches around it. Another stitch through the skin and tubes holds them securely in position. This method was introduced with the object of washing the bladder by injecting fluid through one tube while the other drains it away.

A single tube of similar construction may be used and retained in the bladder by a double row of sutures through the bladder-wall, the second row being Lembert's sutures, so that the wall of the bladder is folded around the tube, and leaking is thus prevented (Gibson[1]).

If suprapubic drainage is to be efficient, it must be free. A rubber tube with a diameter of ¾ or even 1 inch will give more satisfactory results when sepsis is present or hæmorrhage in progress. The length of the tube will depend upon the depth of the abdominal wound. In a man of medium build about 4 inches will suffice, and this allows the tube to project slightly above the skin surface. A large lateral opening is made close to the vesical end. The tube lies just above the trigone, but does not press upon it. The bladder wound will usually grip a tube of this size firmly, so that no sutures are required to close the wall around it, and the bladder itself lies around the intravesical portion of the tube like a funnel. There is seldom any escape alongside a tube of this size. After the abdominal wound is closed a silkworm-gut suture is passed through the skin on one side and through the tube to hold it. A small tube or a wick of gauze is placed in the lower end of the wound and extends down to the prevesical space as a safeguard against leakage. Through a large tube such as this clots are readily removed with forceps, shreds of muco-pus extracted, and the bladder flushed with an adequate stream of antiseptic fluid. The abdominal wound should not be closed too tightly around the tube, as sloughing from pressure will result.

Where septic cystitis is present and infection of the pelvic areolar tissue is feared, the bladder-wall may be brought up and attached to the skin by a few stitches on each side. These sutures are cut after two days, by which time a sufficient barrier has formed against the spread of infection. A voluminous dressing of wood-wool or cellulose tissue is kept in place by means of a many-tailed bandage with perineal straps.

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[1] *Medical Record,* 1901, lix, 45.

If no means of draining away the urine be provided the dressings become soaked and require changing every three or four hours.

Temporary suprapubic drainage is installed in many different conditions, and the length of time it is maintained will vary. After four days a track will have formed and the tube may be removed. From the time of the operation until the closure of the wound, a period varying from fourteen to twenty-one or more days, the urine wells up from the wound and soaks the dressings unless it is removed by some apparatus. To lessen the discomfort of the patient and reduce the possibility of irritation, the skin of the abdomen, scrotum, and the upper part of the thighs is smeared with an ointment containing equal parts of zinc oxide, lanoline, and vaseline.

Methods of draining away the urine. Many methods have been devised for the removal of the urine which will avoid the irritation of the skin and reduce the cost of the dressings. A few of these will be described.

1. *Exhaust methods. Cathcart's apparatus.*[1] This consists of a douche can filled with water and fixed above the head of the bed. From this a rubber tube conducts the water to a glass Y-tube, and the stem of the Y-tube to an S-tube and thence to a pail. The other arm of the Y is connected with a rubber tube which ends in the bladder. The water flowing from the douche can through one limb and the stem of the Y creates a negative pressure in the other limb and in the tube lying in the bladder. This suffices to draw the urine from the bladder into the Y-tube and it flows out with the water. The S-tube forms a trap which regulates the outflow, and the amount of water passing through is controlled by a screw clamp on the rubber tube between the can and the Y-tube. The water is allowed to flow only by drops. The negative pressure obtainable depends upon the distance between the branching point of the Y-tube and the end of the india-rubber tube leading to the pail. About a foot will usually suffice. Mr. Cathcart now interrupts the tube from the bladder to the Y-tube by introducing a bottle in the same way as in the next apparatus.

White's suprapubic evacuator.[2] This apparatus consists of a water-pump, a reservoir for the collection of urine, and bladder connexions (see Fig. 317).

(i) 'The pump consists of a narrow tube, terminating below in a small orifice and sealed into a larger tube with a side arm. The outer and larger tube is contracted below, and to it is attached about 2 feet of narrow rubber tubing terminating in a piece of fine lead piping bent round so as to prevent entry of air into the pump from below.

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[1] *Brit. Med. Journ.*, 1895.

[2] *St. Thomas's Hospital Reports*, vol. xxviii.

'The end is connected with a vessel containing water by means of rubber tubing, and the flow of water can be regulated by a pinch-cock. The water issuing from the fine orifice of the glass tube falls into the constricted neck below, and the diameter of this outflow tube is so small that successive drops of water falling into it carry down bubbles of air which cannot pass upwards through the water separating them owing to the fineness of the bore.

'If the pinch-cock be so far closed that the drops of water fall at the rate of 50 to 100 per minute, an efficient vacuum is maintained with the consumption of only one or two pints per hour. A gallon reservoir of water is therefore sufficient for from four to eight hours' working.'

(ii) The separate collection of the urine is effected by interposing between the pump and the patient a receptacle having one orifice connected with the pump, by which it is rendered vacuous, and another with the bladder tube.

(iii) The bladder connexions. The arrangement consists of an outer silver tube, with a funnel-shaped orifice passing friction-tight through a stout sheet of rubber. This sheet of rubber rests upon the abdomen, and is held in position by bandages passing round the body of the patient. The inner end of the silver tube is closed and rounded to avoid the possibility of injury to the bladder by sucking it into the tube. Just above the closed end two pieces are cut out, and it is also perforated by a series of holes so that the urine may pass freely into it from the bladder. Into this silver tube a glass tube is dropped, reaching to the bottom and bent at right angles. This is connected by a rubber tube with the urine flask, which is placed at the same height as the right angle bend of the glass bladder-tube. The rubber tube is as nearly horizontal as possible. The whole apparatus is arranged in a light metal stand.

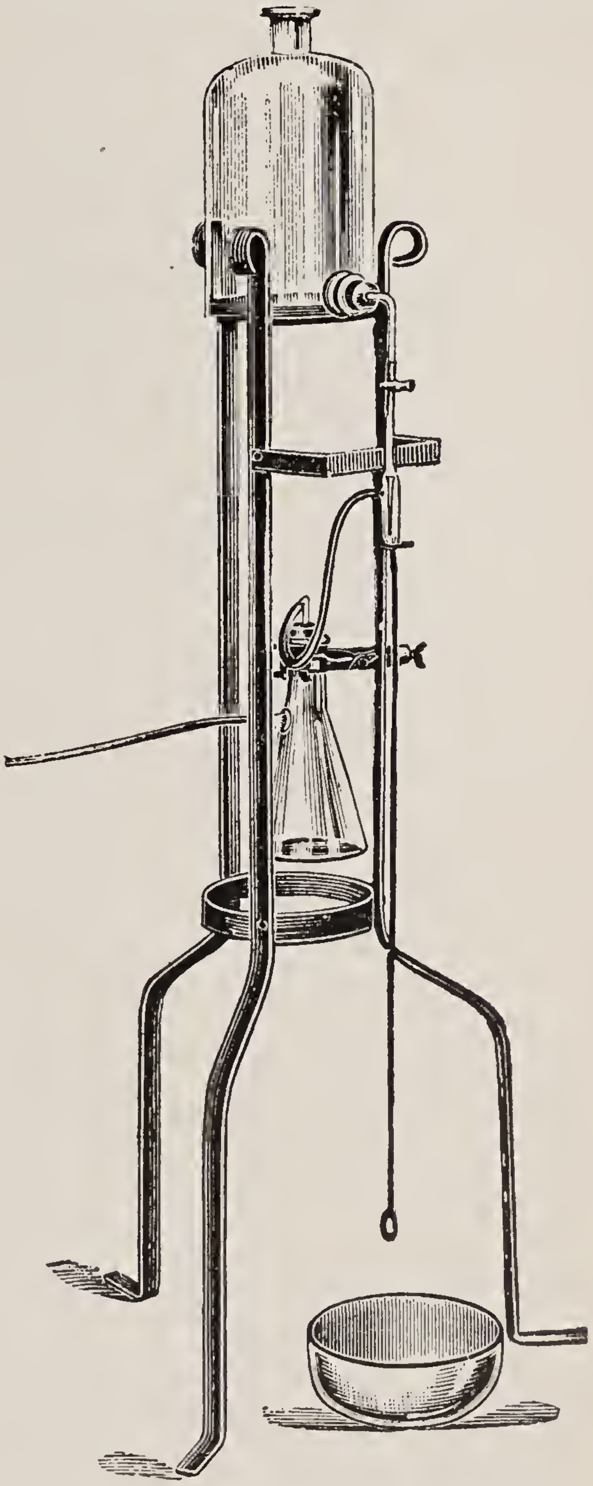

Fig. 317. White's Suprapubic Evacuator.

These evacuators can be applied only during a short period of time when a drainage tube is retained in the wound. In most cases this amounts to four or five days, after which the tube is removed and the wound encouraged to heal. Where hæmorrhage follows the operation and clotting takes place the action of the suction apparatus is impeded.

2. *Siphonage.* If a small tube has been placed in the bladder this may be connected with a length of rubber tubing and carried to a vessel containing fluid under the bed. This will act as a siphon.

If a large tube has been introduced into the bladder a length of Paul's colotomy tubing may be attached to it, brought through the dressing and allowed to hang over a vessel. A little oil should be run through the tubing to prevent the surfaces adhering.

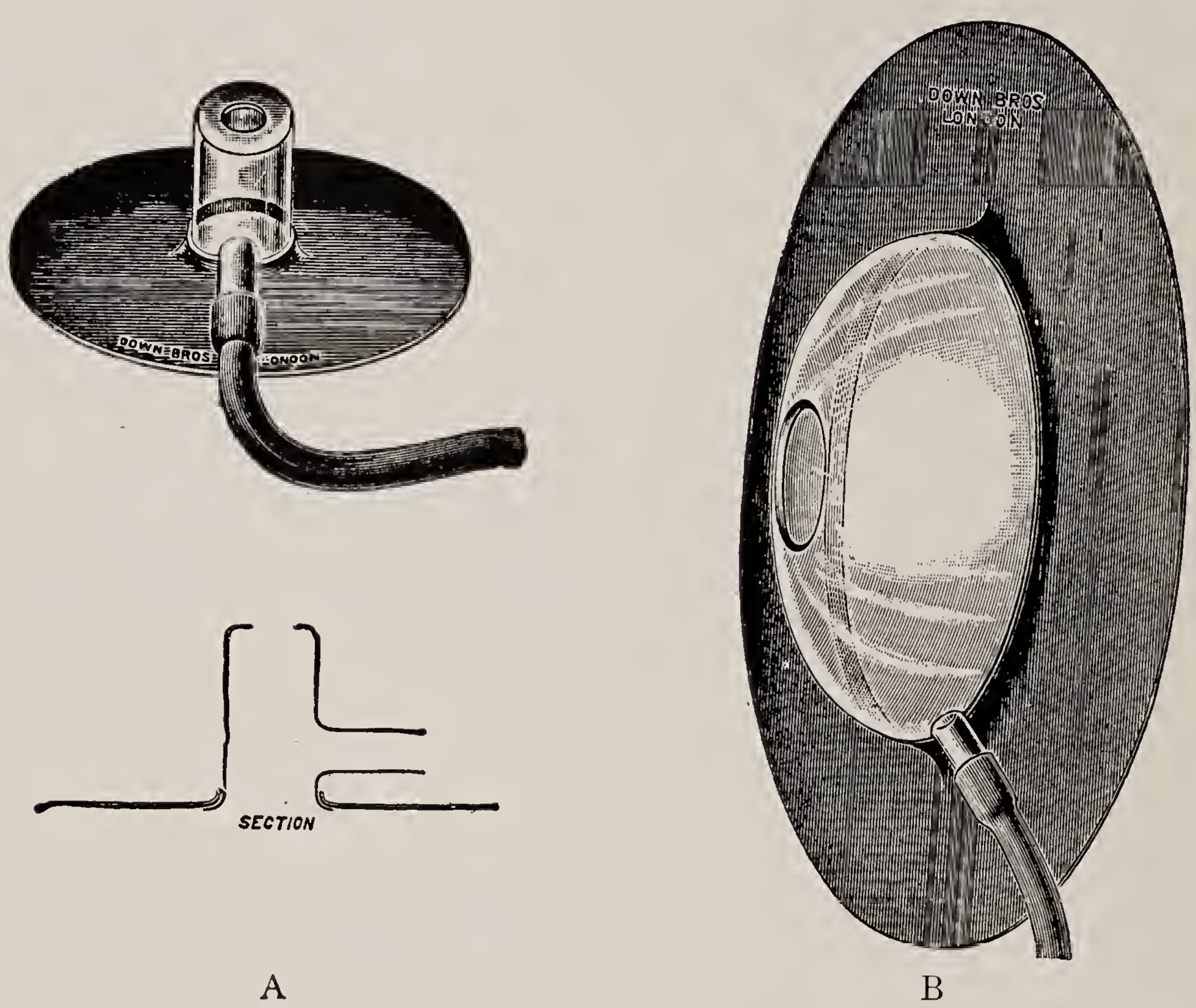

Fig. 318. Colt's Apparatus. a, Suprapubic dressing, round or cylindrical pattern; b, Suprapubic dressing, oval pattern.

The siphonage methods are not very reliable. The siphon action is difficult to control, and, as a rule, acts too powerfully, draining the fluid from the bladder very energetically and then sucking in air which interrupts the action. The second method acts probably more as an overflow than as a siphon and is satisfactory in many cases where a large tube is used. The application of these methods is limited in the same way as in the evacuators just described.

3. *Overflow apparatus.* By means of these instruments the urine is collected as it wells up at the mouth of the suprapubic wound, and conducted into a receiver.

Colt's apparatus. Mr. G. H. Colt has devised an apparatus[1] (see Fig. 318) which consists of (i) a hollow glass cylinder, $\frac{5}{8}$ inch in diameter, with the top partially closed and the bottom turned outwards as a flange. From the cylinder a tube projects at right angles. (ii) A circular disk of rubber, 3 inches in diameter and $\frac{1}{32}$ inch thick. It has a central circular hole $\frac{5}{16}$ inch in diameter, and this fits over the flanged part of the cylinder. The skin of the patient is shaved and cleared of grease for 2 inches round the opening of the fistula. A rubber solution, made by dissolving rubber in naphtha, is applied to the cleansed area of skin, and the under surface of the rubber disk is coated with the same solution.

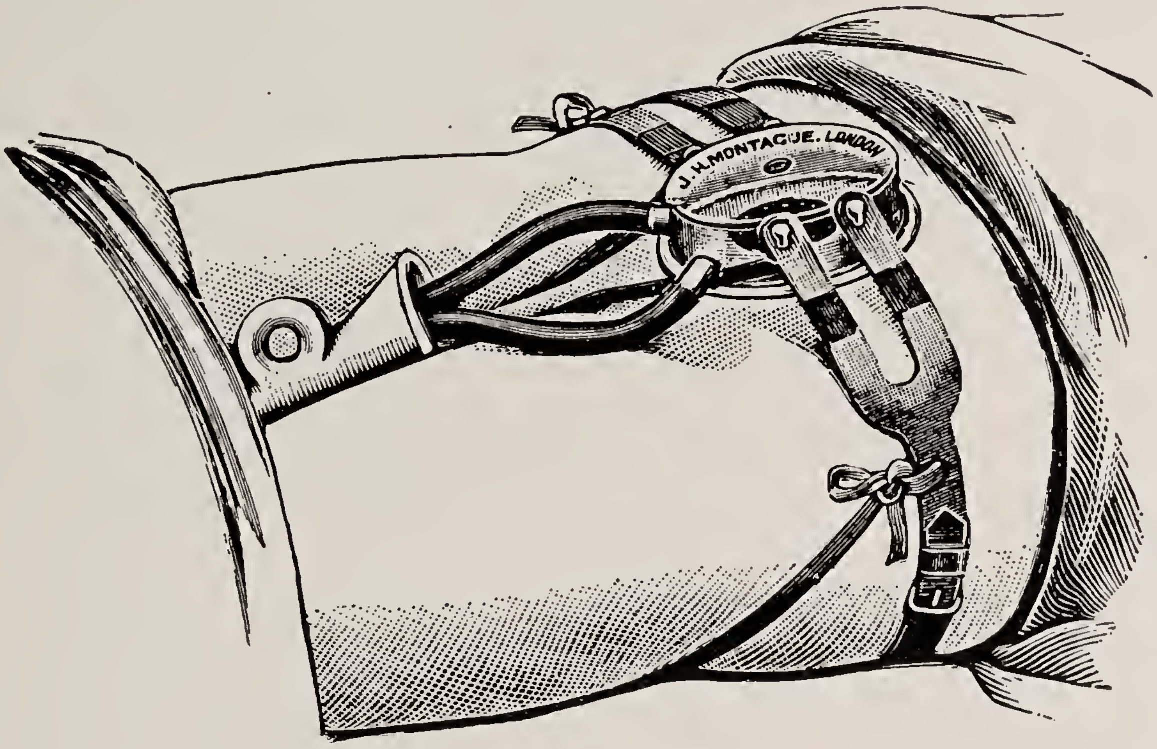

Fig. 319. Irving's Apparatus.

The apparatus is then applied to the wound, and the rubber lies flat upon and adheres to the skin and the glass cylinder projects vertically from the surface. A rubber drainage tube is attached to the branched tube and is fixed to the skin by a broad band of adhesive plaster midway between the anterior superior iliac spine and the orifice of the fistula. The end of the tube hangs in a receptable. The open top of the glass is tightly covered with a piece of gauze. The opening is intended to permit the entrance of air and so prevent siphonage, which has been found to suck out the edges of the fistula and prevent healing.

This apparatus is usually efficient for four days. At the end of this time it becomes loose and should be removed or renewed.

Irving's apparatus.[2] Dr. Hamilton Irving's apparatus (see Fig. 319) consists of a celluloid cap shaped like a straw hat, having a small curved rim and a perforated crown that can be removed like a lid. The

[1] *Lancet,* November 4, 1905; *Practitioner,* June, 1906.

[2] *Lancet,* December 21, 1907.

cap is fastened in place by means of a strap passing round the abdomen, to the ends of which elastic bands are fixed, and a tendency to slip upwards is counteracted by tapes passing from the lower end round the perineum and tied to loops in the abdominal strap. The elastic bands have eyes which fit over hooks on the celluloid cap. The hooks are attached on a level with the lid, so that the elastic pressure is exerted almost perpendicularly and keeps the rim in contact with the skin all round the wound. The urine escapes by two outlets, one on each side of the lower end of the apparatus, and passes through india-rubber tubing into a suitable urine bottle which rests in the bed between the patient's legs. The lid is easily slipped on and off, and has a hole in the centre which admits easily a No. 24 French catheter.

This apparatus has several advantages over the others described above.

It may be applied at the close of the operation and retained until the wound is closed. When, however, there is any likelihood of hæmorrhage taking place, the lower end of the bed is raised on blocks for the first twenty-four hours, and the apparatus is not applied until the bed is lowered to the horizontal. The wound is freely accessible by merely removing the lid. The restriction of the patient's movements is reduced to a minimum.

In most patients the apparatus fits well and is worn with comfort. In thin individuals, however, the ring presses upon the prominent pubic symphysis, and if the abdomen is hollow, leakage may take place at each side. The area within the ring becomes somewhat congested and the wound everted, and in some cases I am inclined to believe that healing is delayed.

In the writer's experience suprapubic cystotomy wounds heal best without any apparatus, and healing may be hastened by a catheter retained in the urethra for a few days when granulation of the wound is nearly complete. The patients do not complain greatly of the discomfort of soaked dressings. If they do, and if expense has to be considered, an Irving apparatus should be applied. In cases where it is necessary that no urine should be allowed to remain in the bladder lest it soil a vesical or urethral wound, White's apparatus is the most satisfactory method by which the urine can be removed.

The relative efficiency of suprapubic and perineal drainage of the bladder. It has been universally held that drainage through a perineal wound taps the lowest part of the bladder and that suprapubic drainage fails to do this. The perineal drainage tube enters the bladder through the internal meatus. It is true that in a child standing erect the lowest part of the bladder is the internal meatus. In an adult male standing erect the lowest part of the bladder will be behind this, and when he is lying on his back the lowest part of the bladder is well behind the interureteric bar. A surgeon accustomed to perform litholapaxy recognizes this from the position in which he feels for a stone with the lithotrite. The portion of the perineal drainage tube which projects through the internal sphincter is thus several inches above the lowest part of the bladder. The suprapubic drainage tube passes down as far as the trigone, and the bladder contracts around it. A tunnel is thus formed, at the lower end of which is the posterior part of the trigone and post-trigonal pouch. Suprapubic drainage therefore taps a lower level than does perineal, and if siphonage or suction be applied, the bladder may be kept practically dry.

A further advantage of suprapubic drainage is that a much larger drainage tube can be used, through which washing of the bladder can be performed, and that the suprapubic wound is more easily attended to and kept clean.

PERMANENT SUPRAPUBIC DRAINAGE

Permanent drainage of the bladder may be required for malignant diseases of the prostate or for other conditions.

After suprapubic cystotomy the wound is allowed to contract down to the size of a No. 30 French catheter, and a soft rubber instrument of this size is passed along the fistula into the bladder. Over the surface of the suprapubic scar a silver plate is adjusted, and in the middle of this is fixed a bent silver tube about 2½ inches long (see Fig. 320). The catheter when stretched passes easily through this, but when relaxed fits it securely. The metal plate is strapped on by means of a waist-belt. The catheter is carried into a rubber reservoir strapped to the patient's thigh. A patient can get about in comfort with this apparatus.

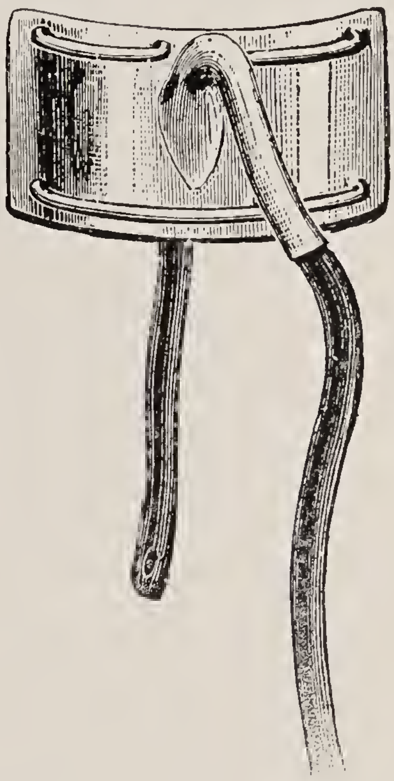

Fig. 320. Apparatus for Permanent Suprapubic Drainage.

CHAPTER IX

OPERATIONS FOR TUMOURS OF THE BLADDER

Before performing an operation upon the bladder for growth a careful examination should be made with the cystoscope, so that an opinion may be formed as to the accessibility of the growth, and its extent and character.

At this preliminary examination the following points should be noted:—

1. The position of the growth in the bladder and its relation to the ureters and internal meatus.
2. The number of growths.
3. Whether the growths are pedunculated or sessile.
4. The character of the surface of the growths, whether fimbriated, raspberry-like, smooth, nodular, or irregular.
5. Evidence of infiltration, ulceration, phosphatic deposit, or necrosis.
6. The presence of cystitis.

I am in the habit, when dealing with multiple papillomata, of making, at the time of the preliminary cystoscopy, a chart of the exact position and size of the villous tumours, and at the operation this is kept before me. When more than one growth is present this is necessary, for it is easy to overlook a small bud of papilloma after several large masses have been removed. It is an easy matter to count and localize a number of papillomata with the cystoscope when the bladder is fully distended, but it is less simple to find them when the bladder is open and collapsed. When the operation has been some time in progress the mucous membrane of the bladder frequently becomes swollen and œdematous and the wall rigid, and this adds to the difficulty of searching for small papillomatous buds when no chart lies before the operator.

FOR NON-MALIGNANT GROWTHS

Excision of the growth with the mucous membrane surrounding its base is the most thorough method.

This is carried out in the following manner: The bladder having been opened above the pubes, a suture of catgut is passed through each lip of the bladder wound, and the sutures are pulled upwards so as to raise the bladder well into the wound. The patient is now placed in the Trendelenburg position, and the edges of the bladder wound retracted so as to display the growth (see Fig. 326). Even with the inclined position of the patient there is a tendency for the intestines to push the posterior bladder-wall towards the pubes and so obscure the base of the bladder. This is obviated by tucking a roll of gauze into this part of the bladder and placing a retractor over it at the upper angle of the wound. Another retractor may be placed on each side, but often a single one at

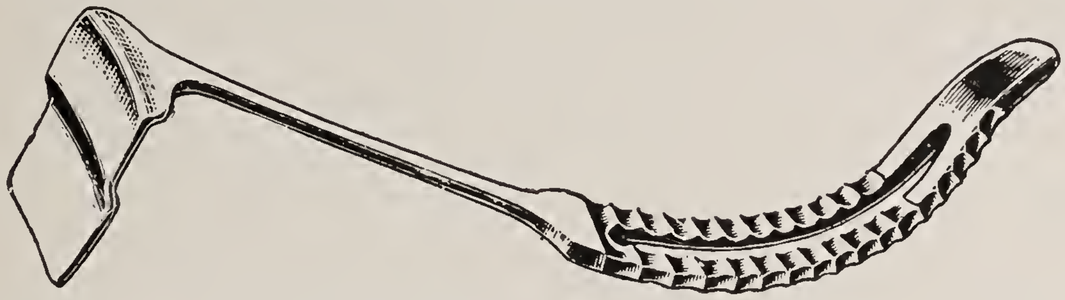

FIG. 321. AUTHOR'S BLADDER RETRACTOR. The part next the shank retracts the abdominal wall and the cut edge of the bladder-wall by direct horizontal traction. The intravesical part pushes back the bladder-wall by a tilting movement. The traction and tilting are easily obtained by grasping the handle with the thumb directed upwards.

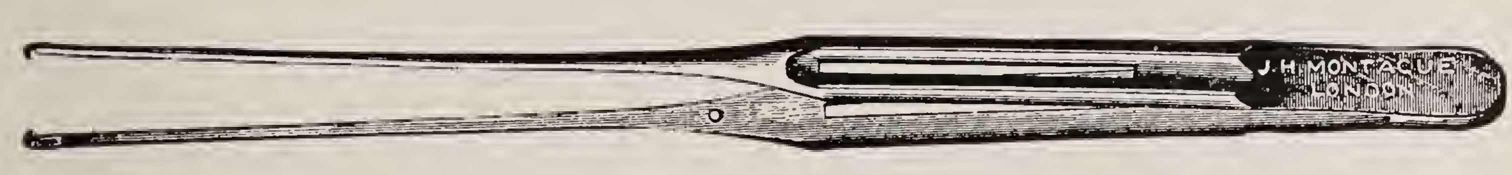

FIG. 322. TOOTHED FORCEPS FOR BLADDER OPERATIONS.

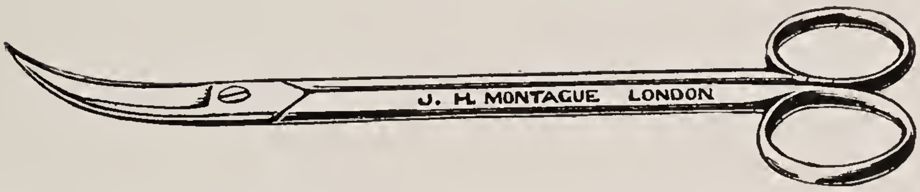

FIG. 323. SCISSORS FOR INTRAVESICAL OPERATIONS.

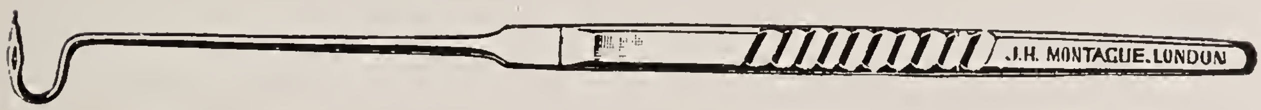

FIG. 324. FINE NEEDLE FOR SUTURE OF THE BLADDER MUCOUS MEMBRANE.

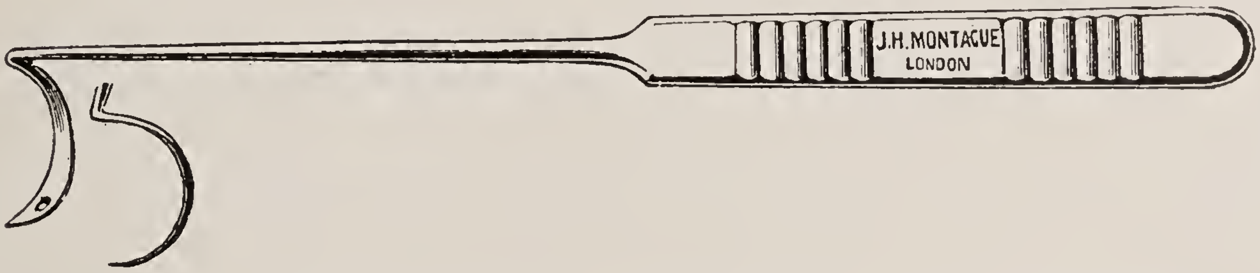

FIG. 325. LARGE NEEDLE FOR SUTURE OF THE BLADDER-WALL.

the upper angle will give a good exposure of the tumour. I use retractors of different sizes, which are specially designed to overcome the inward bulging of the posterior and lateral walls, and to give plenty of room for intravesical manipulation (see Fig. 321). For removing the growth the following instruments are useful: Fine toothed forceps 7½ to 8 inches long, to pick up the mucous membrane (see Fig. 322); long, fine curved, sharp-pointed scissors, not less than 8 inches (see Fig. 323); several pairs of long fine serrated forceps by which small pledgets of gauze or cotton-wool are applied to the cut surface; a long fine sharp hook to steady the bladder-wall if necessary; several fully curved needles of different sizes with a diameter of one inch and less, set at right angles, right and left, on a fine handle not less than 8 inches long (see Figs. 324, 325); and long fine artery forceps. An electric forehead-lamp should be used.

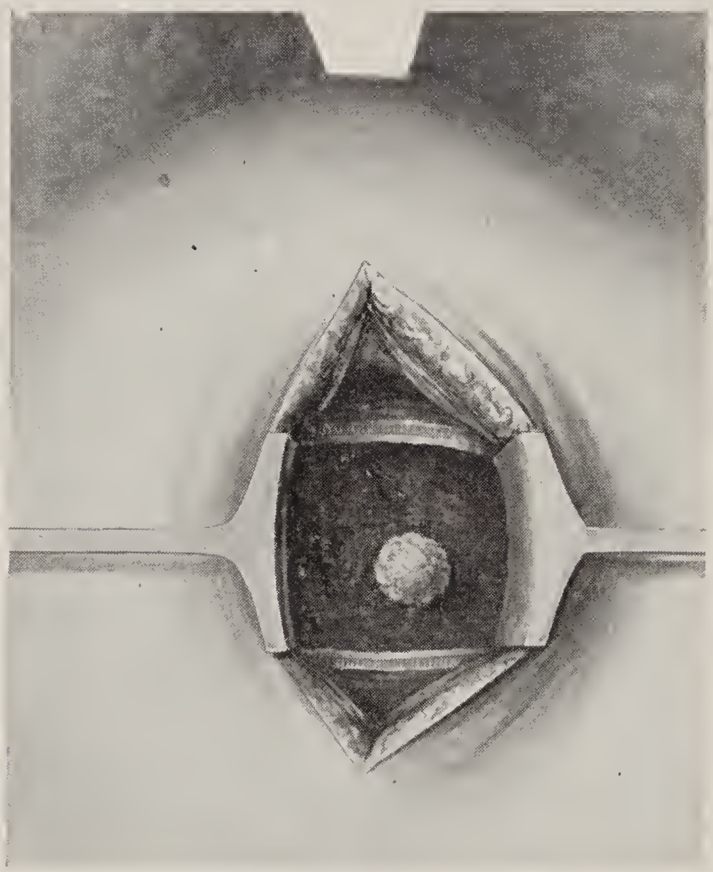

Fig. 326. Exposure of a Papilloma of the Bladder. The papilloma is situated behind and to the right of the trigone.

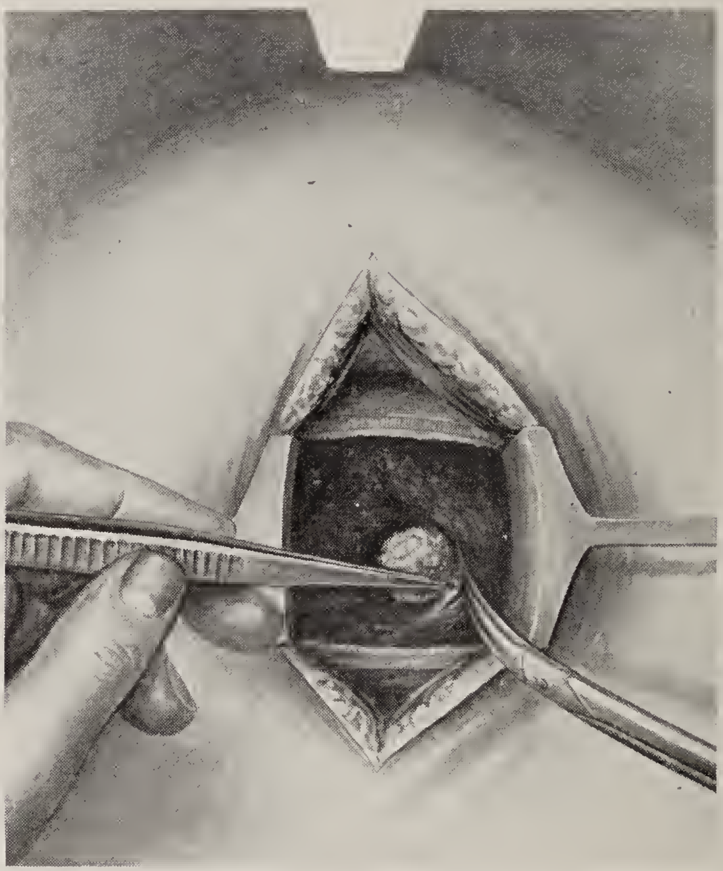

Fig. 327. Removal of a Papilloma of the Bladder. *First stage.* Incision of the mucous membrane.

The mucous membrane of the bladder is picked up just above the base of the tumour and gentle traction made upon it. This raises the area of mucous membrane around the base sufficiently to make it prominent. No attempt should be made to drag the growth and surrounding mucous membrane up into the wound. With the curved scissors the mucous membrane is cut through around the base of the stalk, leaving a narrow rim of mucous membrane all round, and cutting outside the forceps so that they remain attached to the mucosa of the tumour (see Fig. 327). The mucous membrane retracts and, if the pedicle is fibrous, the firmer fibrous core is exposed. This is clipped through with scissors, cutting well into the muscular tissue in doing so (see Fig. 328). In many of these growths the pedicle is very delicate, and the tumour comes away when the mucous membrane is cut through. A long pair of pressure-forceps is clamped on the bleeding point, and left on for a short time. When they are removed the bleeding has ceased. The wound in the mucous membrane is closed with one or two sutures of very fine catgut (see Fig. 329). These should be tied with extreme gentleness lest they tear through the delicate mucous membrane.

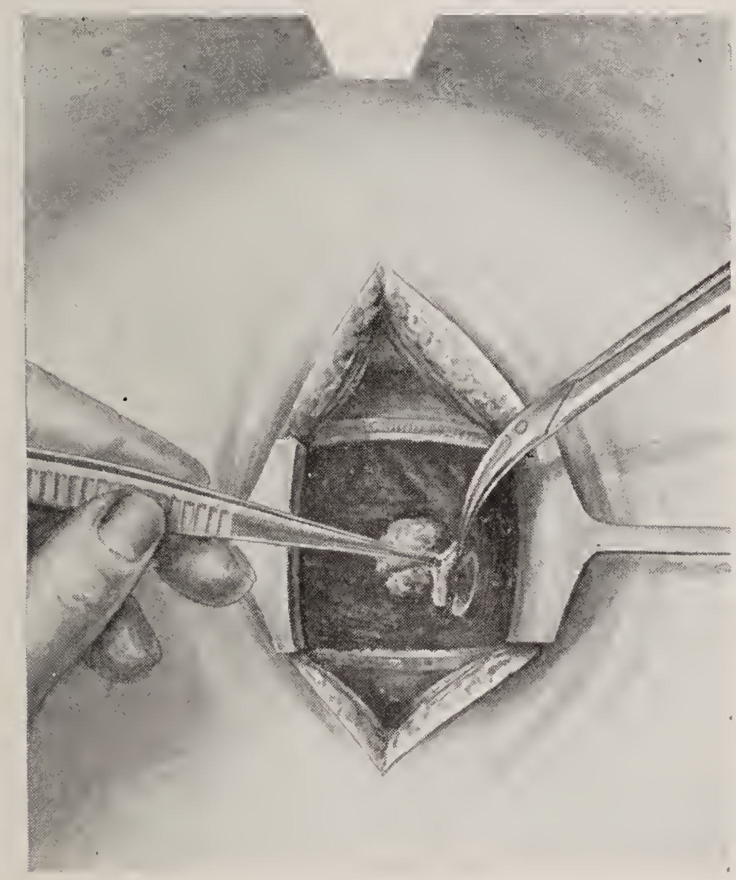

Fig. 328. Removal of a Papilloma of the Bladder. *Second stage.* Cutting through the pedicle after incision of the mucous membrane.

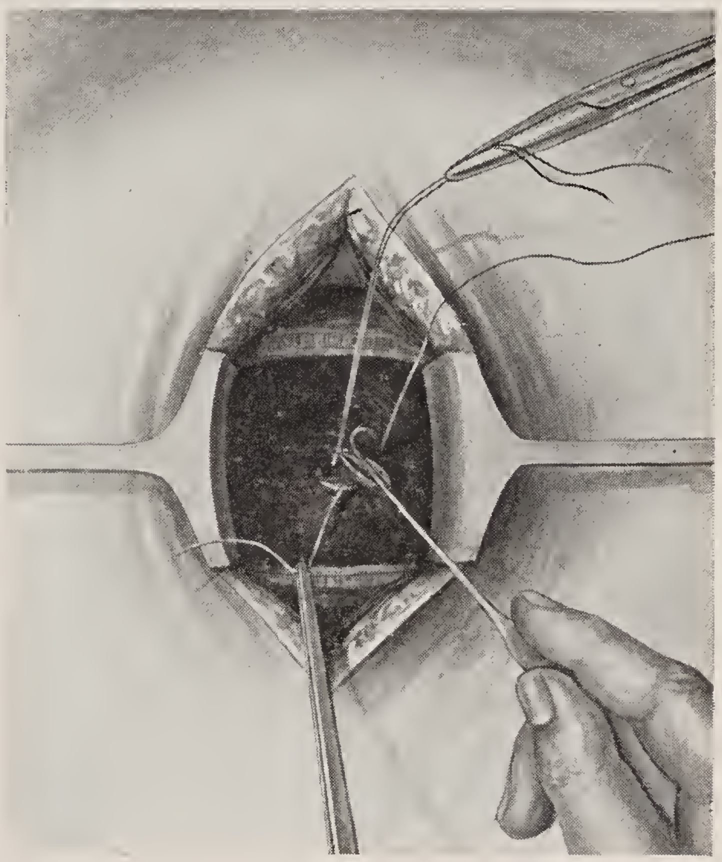

Fig. 329. Removal of a Papilloma of the Bladder. *Third stage.* Closing the wound in the mucous membrane with interrupted sutures.

A small bud of papilloma may be steadied with forceps and clipped off with curved scissors, removing with it a portion of the adjacent mucous membrane. The edges of the small wound are brought together with a single stitch of fine catgut, or a few touches of a fine electric cautery point will sear the surface and stop the bleeding. The treatment described above is suitable either for pedunculated or sessile papillomata.

When an area of mucous membrane is covered with a number of closely set papillomata it is better to remove the strip of mucous membrane bearing the growths and bring the edges together with interrupted sutures of fine catgut after clamping any spouting vessels. Occasionally a ligature may be required for a vessel, but usually a short application of pressure-forceps will suffice, and arrest any bleeding.

Another method is to place a clamp upon the base and cut off the tumour with curved scissors close to the clamp. Guyon's clamp (see Fig. 330) is specially constructed for this operation. Several sutures of fine catgut may now be passed through the base of the pedicle on the bladder side of the forceps. The clamp is then cut away with curved scissors, and the catgut stitches tied. If oozing continues between the stitches, one or two additional stitches may be introduced obliquely through the muscular layer and tied. Instead of placing stitches in the base of the tumour, the portion which lies in the grasp of the blades of the clamp may be seared with a fine electric cautery point and the clamp then removed.

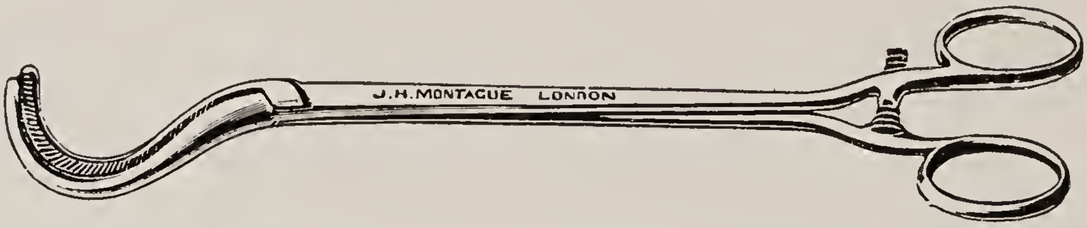

FIG. 330. GUYON'S CLAMP FOR BLADDER TUMOURS.

Fenwick uses the following method: A porcelain speculum similar to a Fergusson's vaginal speculum is introduced into the bladder through the suprapubic wound and sunk to the base, against which the rim presses. Within the circle is the papilloma, which is thus shut off from the rest of the bladder. Any fluid in the 'caisson' is removed by gauze plugs, and the tumour is examined with the light of the head-lamp. If it be pedunculated the pedicle is clamped with curved serrated forceps, and the growth cut away and removed from the 'caisson.' The speculum is now removed, and a finer clamp is applied to the base of the pedicle on the bladder side. The first clamp is cut away with the pedicle in its grasp; the second clamp is left on the base for twenty-four hours and then removed. Small sessile papillomata are bitten off with cup-shaped cutting forceps, and the base touched with a dab moistened in perchloride of iron, and the surface pressed for a few seconds with a dry dab.

Oozing from the mucous membrane is sometimes troublesome after any of these methods. It is controlled by washing the bladder through the catheter in the urethra with a copious stream of hot boracic lotion (110°F.). Extract of suprarenal gland may be used to control this type of bleeding. It should be applied directly to the bleeding spot on a pledget of cotton-wool. After such an operation for papilloma the bladder wound may be closed if the surgeon be satisfied that the bleeding has ceased. This is carried out in the manner described on p. 623, and with the precautions there noted. A large-sized coudé catheter (20, 22) is tied in the urethra, and retained for four or five days.

FOR MALIGNANT GROWTHS

Sonnenburg[1] was the first to resect a portion of the bladder-wall in its entire thickness.

The extent and method of the operation will vary according to the position and size of the growth, and the operation will therefore be considered according to the position of the growth.

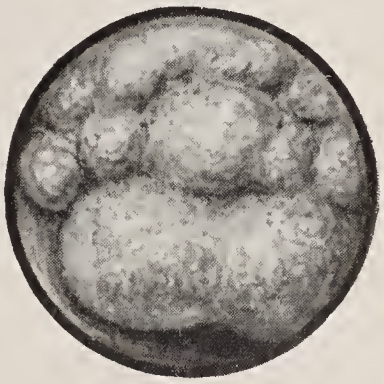

Fig. 331. Cystoscopic View of a Malignant Growth of the Bladder. This growth, after resection of the bladder-wall, is shown in Fig. 336.

For a growth situated at the upper part of the anterior or lateral walls. The patient is placed in the Trendelenburg position. The bladder is exposed by a vertical incision (see p. 619), and the recti fully retracted. The situation of the growth has been primarily ascertained, and some idea of its extent gained by cystoscopy (see Fig. 331). With the finger the induration of the bladder-wall is now exactly defined. The wall of the bladder is freed from the posterior surface of the pubic bones, and if the bladder has previously been operated upon, tough fibrous adhesions will have to be dissected. The peritoneum is carefully stripped up to the apex of the bladder, and especial care is required in doing this if the operation be a secondary one. The peritoneum should also be stripped from the lateral walls of the bladder if the induration be felt to approach one or other side. Having now cleared the whole of the probable field of operation, a vertical incision is made through the bladder-wall well beyond the area of induration on one or other side of it (see Fig. 332). The distending fluid is allowed to escape. A fixation suture of catgut is inserted through each lip of the wound, and includes the whole thickness of the bladder-wall except the mucous membrane. These are clamped with pressure forceps and held up by an assistant. The finger is now introduced into the bladder and the extent of the induration defined on the mucous surface.

The writer adopts the following method for the further steps of the operation: By drawing upon the traction sutures the bladder-wall is pulled well up into the abdominal wound and steadied there. The blad-

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[1] *Verhandl. d. deutsch. Gesellsch. f. Chir.*, 1885.

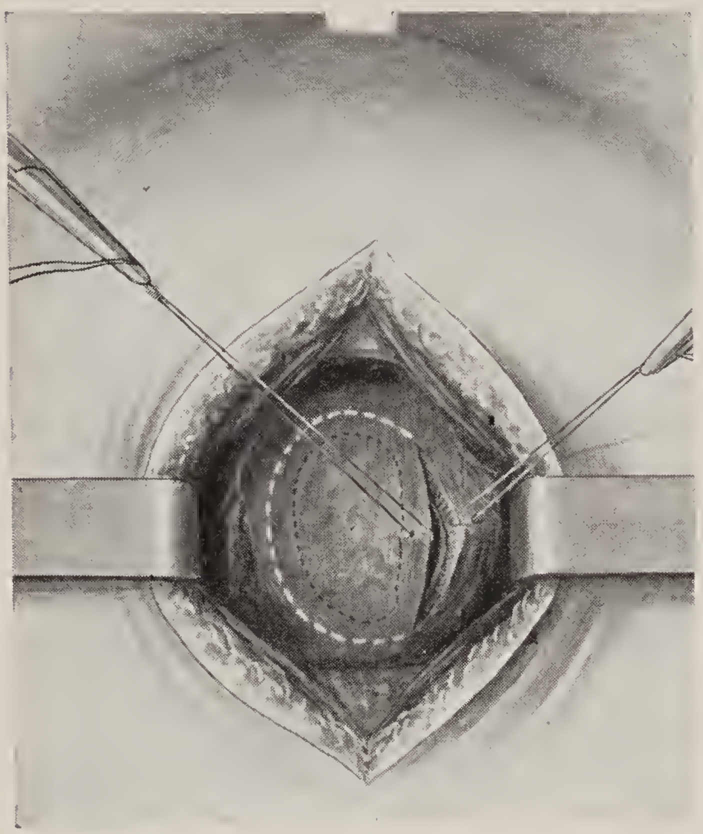

Fig. 332. Resection of the Anterior Bladder-wall. *Showing area of proposed resection.* The inner dotted circle shows the extent of the growth. The larger dotted circle shows the extent of the proposed resection.

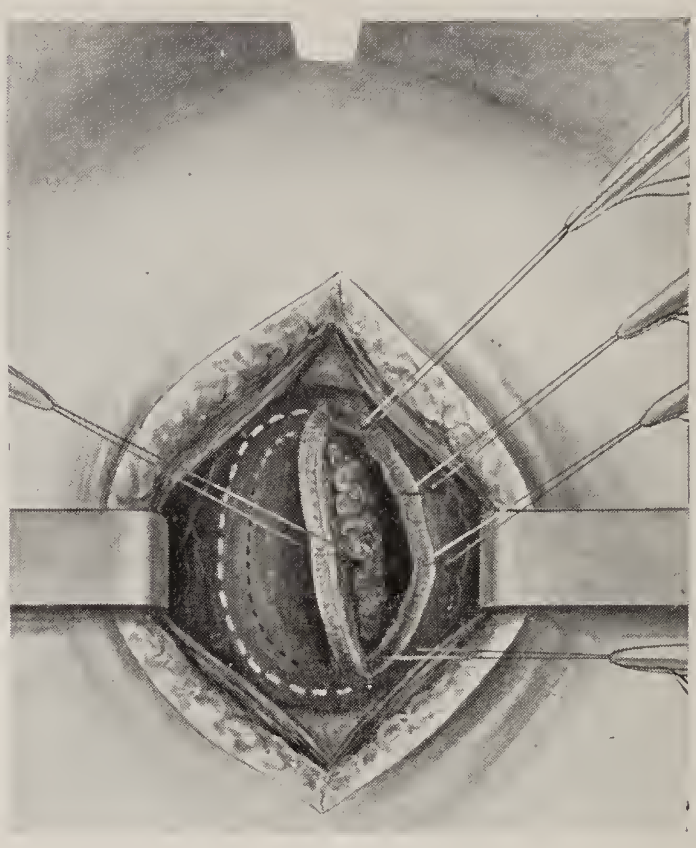

Fig. 333. Resection of the Anterior Bladder-wall. *Exposure of the growth.* The incision has been extended and the growth can now be seen. Traction sutures have been inserted.

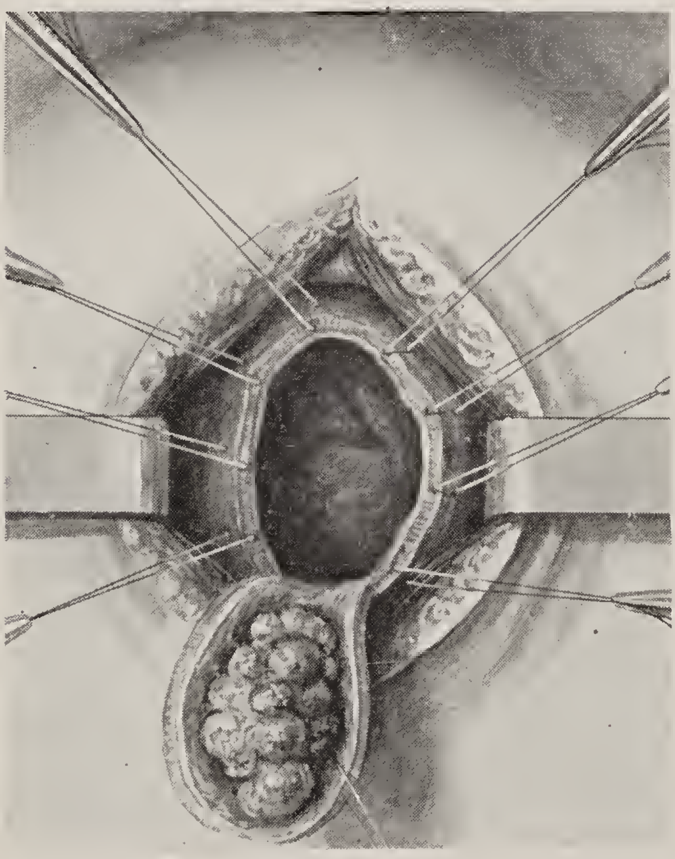

Fig. 334. Resection of the Anterior Bladder-wall. *Removal of the growth.* The growth-bearing area with a margin has been turned back as a flap. Traction sutures steady the bladder-wall.

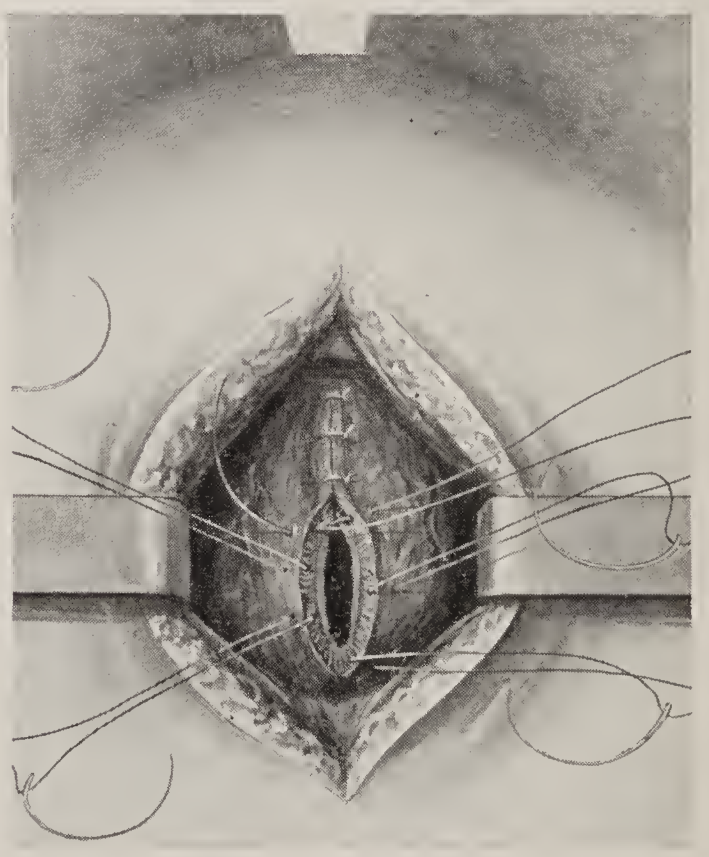

Fig. 335. Resection of the Anterior Bladder-wall. *Closure of the bladder-wall.* The growth-bearing area has been removed and the traction sutures are utilized to close the bladder-wall.

der wound is now extended downwards with blunt-pointed scissors, cutting through the whole thickness of the bladder-wall (see Fig. 333). As the wound extends towards the pubes, a better view of the interior of the bladder is obtained. At each ½ inch a traction suture of catgut is introduced through the bladder-wall on the side of the wound opposite the growth. These sutures do not penetrate the mucous membrane. The last one introduced is held up by an assistant to steady the bladder-wall, while the others are clamped and laid in order over the abdomen. Here and there a vessel in the bladder-wall spouts and is picked up in long artery forceps. The incision is carried round the lower end of the growth on the other side towards the apex of the bladder. A large flap of the bladder-wall is thus turned upwards, bearing the growth with a good margin of healthy mucous membrane and muscle all round (see Fig. 334). This flap is now cut away, taking care that the peritoneum has been reflected from the outer surface of this part of the bladder (see Fig. 336). In following the growth upwards to the apex or on to the posterior wall, it may be found impossible to reflect the peritoneum, which is bound down by firm adhesions. In this case the peritoneum must be opened, the edges picked up in forceps, and the cavity packed off. When the growth has been removed, the opening in the peritoneum is closed with a continuous catgut suture. The bladder-wall around the large defect is now supported by a series of traction catgut sutures arranged round the wound. If the patient be collapsed, a drainage tube may be inserted, and those sutures which are opposite are tied together and the bladder thus rapidly closed. If, however, the operation has been well borne, the inner end of each traction suture is threaded in a large curved needle, and passed through the edge of the bladder-wall on the opposite side of the defect, avoiding, as before, the mucous membrane (see Fig. 335). A series of sutures, ¼ inch apart, are thus obtained. The clots are now cleared out of the bladder and a drainage tube placed in the wound towards its lower part, so that the track left after its removal will be oblique. The

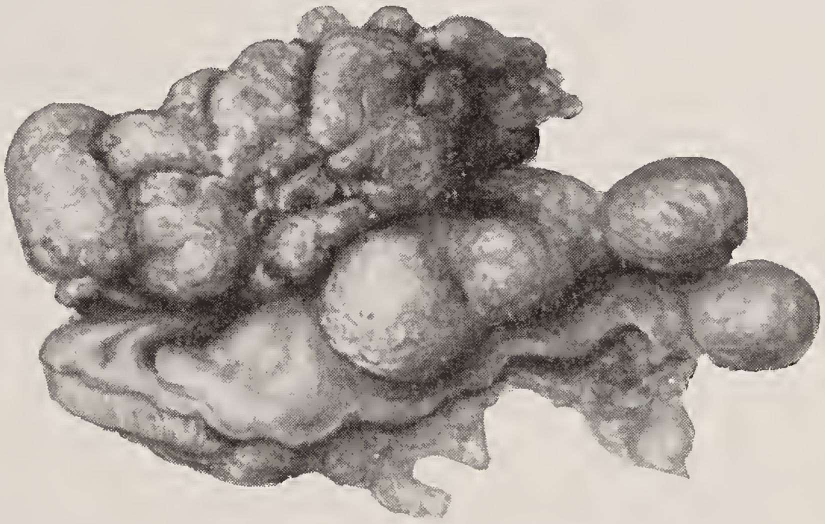

FIG. 336. MALIGNANT GROWTH OF THE BLADDER. Specimen showing part of the bladder resected for removal of growth. Note the margin of healthy mucous membrane and the layers forming the whole thickness of the bladder-wall.

sutures are now tied off from the apex of the bladder towards the urethra; a second row of Lembert's sutures may be added to this, but where a drain is inserted they are not absolutely necessary. One or two stitches may be passed through the superficial layers of the bladder muscle on each side of the wound and the deep layer of the recti muscles so as to shut off the lateral area of pelvic areolar tissue.

For smaller growths less extensive resection may be required, and the bladder wound may be completely closed and a catheter tied in the urethra.

For growths affecting the upper part of the posterior wall. The patient is placed in the Trendelenburg position, the anterior surface of the bladder exposed, and the peritoneum carefully stripped off the apex and posterior wall of the bladder. If the peritoneum be found adherent over the growth so that it cannot be detached it will be necessary to open the peritoneal cavity. If the growth be readily accessible near the apex of the bladder, this will be done before opening the bladder. The membrane is stripped off as far as possible and then incised and clipped round the edge of the adherent portion with scissors. The rent is now closed with a continuous catgut suture and covered with a large pad. If the growth be situated lower down and be less accessible, the bladder should be emptied and the growth accurately defined before opening the peritoneal cavity. The bladder is incised in the middle line anteriorly near the apex and the distending fluid allowed to escape and carefully mopped up. The finger is introduced into the bladder and the growth defined. With the bladder collapsed the posterior surface can be more easily reached, and the peritoneum is incised at the edge of the adherent area and treated as above. A portion of omentum may adhere to the peritoneal aspect of the growth, and this should be tied and cut adrift.

Having closed the peritoneal wound, the bladder wound should be extended backwards so as to encircle the growth.[1]

The same means of raising and fixing the edges of the wound above described are used. After removal of the growth the traction sutures are pulled up and used to close the wound, working from the apex of the bladder down the posterior wall. A second row of Lembert's sutures is placed over the first. A large drain is inserted in the anterior part of the wound. It is sometimes necessary to incise the inner borders of the recti muscles or to cut one rectus across partly or completely. This is done with the precautions stated on p. 626, and the edges of the severed muscles are carefully united after the operation.

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[1] Bardenheuer (Göcke, *Deut. med. Wochenschr.*, 1897) recommended that if the peritoneum had to be resected the operation should be done in two stages. The peritoneum should be resected and stitched, and after fourteen days, when the peritoneal wound was healed, the removal of the growth should be carried out. This precaution is not, however, necessary, for the peritoneal wound seldom gives rise to any trouble.

Transverse cystotomy (see p. 625) is seldom necessary.

For growths affecting the base of the bladder or the lower part of the anterior, lateral, or posterior walls with the base. The choice of operation in these cases will lie between partial resection and total extirpation of the bladder. When a partial resection has been decided upon, the first care of the surgeon will be to examine the relation of the growth to the ureters. If one or other of these ducts be involved in, or surrounded by, the growth a preliminary operation for the transplantation of the ureter will be necessary. A ureteral catheter is passed along the duct, the peritoneum is stripped from the lateral wall of the bladder until the ureter is reached, and the duct is traced down as far as possible and cut across close to the wall of the bladder. The catheter is now removed and a fine thread of silk passed through the lower end of the ureteral wall. The duct is set aside until the resection of the bladder-wall is completed. The method by which the ureter is implanted in the bladder is discussed elsewhere. If the ureters be free from the growth a ureteral catheter is introduced into the duct on the side on which the bladder is affected. This should be done at a preliminary cystoscopy and the operation performed forthwith. Where this is found impossible, from the position or exuberance of the growth, the catheter should be introduced through the suprapubic wound. It is necessary that the ureter should thus be safeguarded, for otherwise it will be impossible to recognize the intramural portion of the duct during the operation.

A vertical abdominal incision with limited section of the recti muscles will usually suffice to give a good exposure even in stout muscular subjects. Occasionally a transverse incision through the abdominal wall may be considered advisable in a stout patient.

The writer has performed the following transvesical resection of the bladder-wall on several patients and removed the growths completely, with the whole thickness of the muscular wall.

Having exposed and incised the bladder, the anterior wall should be examined, and if a contact ulcer is present this should be excised by extending the incision round it. The main growth is now examined and fully exposed by a bladder retractor on the side opposite to the growth, and a large roll of gauze is tucked into the posterior wall and another retractor placed over it. A powerful head-lamp is necessary, and two assistants are useful, one to retract and one to sponge. The sponges are small plugs of sterilized gauze on long forceps. The mucous membrane of the bladder is seized with long forceps about ½ inch beyond the edge of the growth and cut through with long curved sharp-pointed scissors, and this incision is carried downwards along the anterior aspect of the growth, keeping ½ inch beyond the margin of the growth. The incision is then carried along the posterior aspect of the growth, having a similar margin of healthy mucous membrane. The bleeding is not severe. One or two vessels are picked up in long pressure forceps, which are left on for a few minutes.

The wound is now deepened through the muscular substance, commencing above and working downwards along the anterior and then along the posterior aspect and picking up any vessels that spout. The upper end of the growth, together with the whole thickness of the muscular bed on which it is implanted, is thus freed, and may now be grasped with volsella forceps and gradually raised as the dissection proceeds (see Fig. 337). The point of the left forefinger is pushed under the tumour and detects strands of tissue that hold it down and vessels that pass into it. Curved blunt-pointed scissors keep in touch with the pulp of the finger and cut through the bands that hold the tumour down. The upper end of the flap, consisting of the tumour and the whole thickness of the bladder-wall, is gradually raised up, and the incision in the mucous membrane is now carried round the base and marks out the whole area to be removed. The growth is pulled backwards and the bladder muscle cut through along the anterior surface and round its inner end until the whole mass can be raised and turned back, and the section of the muscle on the posterior aspect of the tumour completed by cutting from below. Having carried this through to the incision in the mucous membrane, the whole mass is removed.

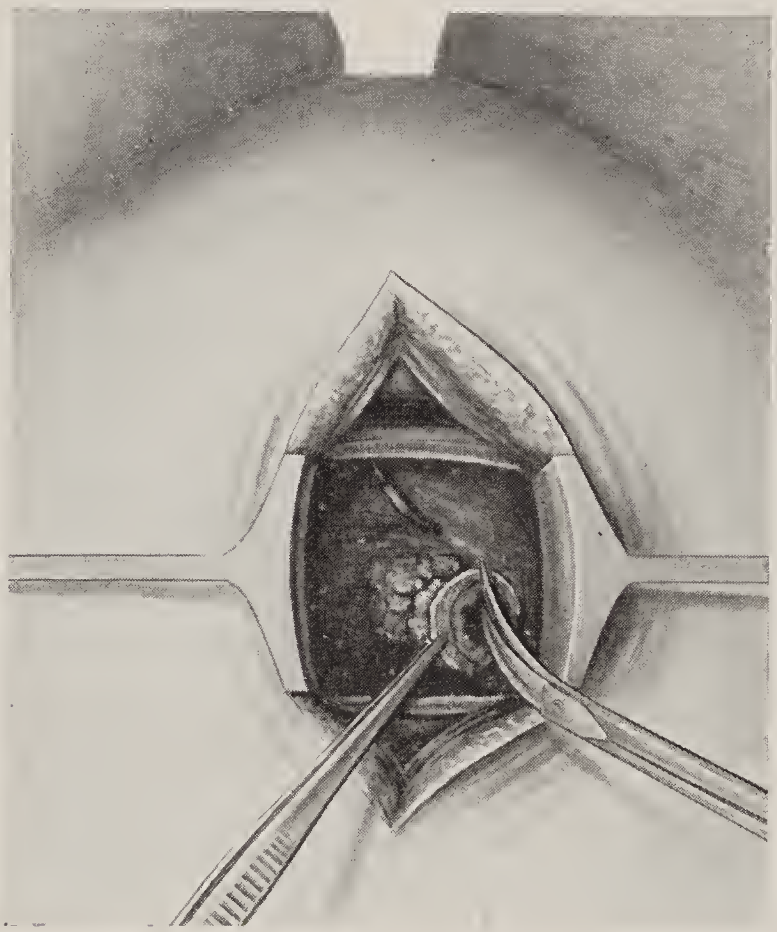

Fig. 337. Transvesical Resection of the Bladder-wall. *First stage.* The whole thickness of the bladder-wall has been cut through above the growth. A flap, consisting of mucous membrane, bladder muscle, and perivesical fat, is held up with forceps while the wound is extended with curved scissors. A ureteral catheter lies in the right ureter.

Any bleeding from the bladder-wall is now stopped, and one or two catgut ligatures may be required. In the floor of the bladder wound will be found the perivesical areolar tissue and fat and sometimes the upper part of the prostate. At the stage when the flap is being raised, some veins of the lateral part of the vesico-prostatic plexus may be torn or cut across and a troublesome venous bleeding take place. A strip of gauze should be packed under the mass as the operation progresses and tucked in with forceps. When the growth has been detached the packing is removed and bleeding will probably have ceased. Any points that still bleed should be picked up in long pressure forceps and catgut ligatures applied. If resection of the ureter has been necessary, the silk suture which was passed through the lower end of the duct is now threaded on an aneurysm needle and passed through the wound in the bladder-wall. The ureter is drawn through at the upper angle of the wound; the end is trimmed, cut obliquely, and stitched to the mucous membrane and muscles. If the ureter be too short to reach to the wound, it will have to be implanted into another part of the bladder-wall. With a fully-curved needle set on a long holder, the bladder muscle on each side of this irregular wound is now united by a number of interrupted sutures (see Fig. 338), commencing at the highest end of the wound and leaving each suture long, so that by gentle traction upon it the next part of the wound will be brought up ready for the

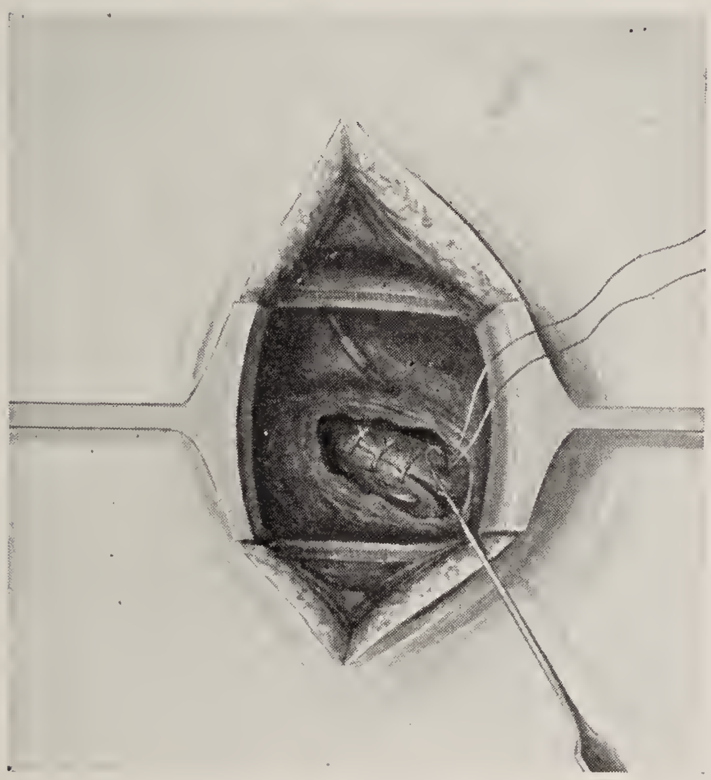

Fig. 338. Transvesical Resection of the Bladder-wall. *Second stage.* Closing the wound in the bladder muscle with interrupted sutures.

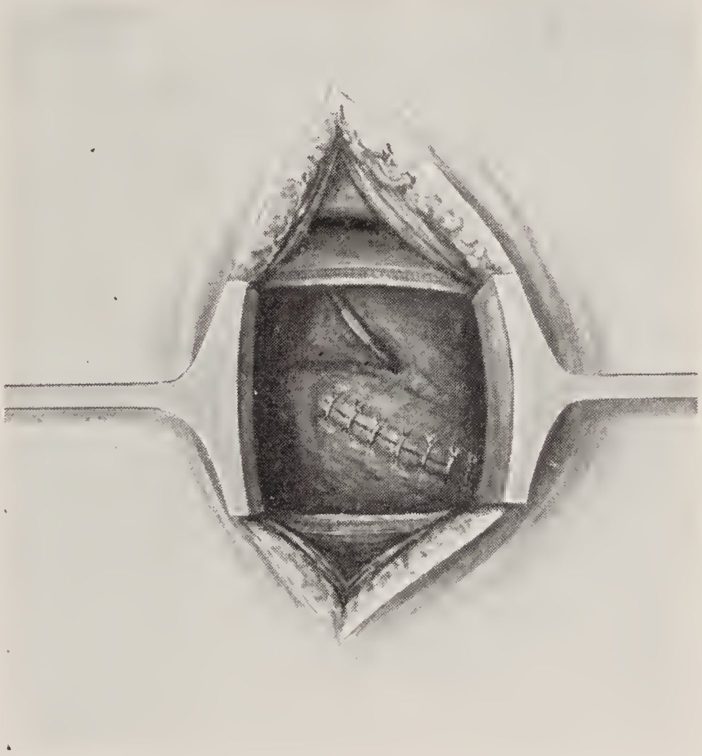

Fig. 339. Transvesical Resection of the Bladder-wall. *Third stage.* The mucous membrane has been united with interrupted catgut sutures.

next suture. Over this the mucous membrane should be united, using fine catgut and small curved needles and avoiding stripping up and tearing the delicate mucous membrane (see Fig. 339). The ureteral catheter is withdrawn.

All packing and swabs are now removed from the interior of the bladder, which is flooded with a stream of hot boric lotion passed through a catheter in the urethra. A large drainage tube (1 inch in diameter) is placed in the bladder and the wall closed around this. The abdominal wound is treated in the manner described on p. 623.

After-treatment. For the first twenty-four hours the patient should lie on the side opposite to that from which the growth was removed, so as to prevent, as much as possible, soaking of the wound with urine.

After this time a White's suprapubic evacuator (see p. 633) should be adjusted and the bladder drained for a week.

Either once or twice a day, according to the state of the urine, the bladder is flushed through the large suprapubic tube with several pints of weak, unirritating, antiseptic solution (biniodide of mercury, 1 in 15,000). At the end of a week the evacuation apparatus and tube are removed and a large-sized coudé catheter tied in the urethra for eight or ten days.

For a circumscribed growth surrounding the ureteral orifice. The following operation is described by Albarran:[1]

Transverse cystotomy is performed, and if possible a catheter passed into the ureter. An incision is made with a bistoury through the mucous membrane around the growth, including the ureteric opening. The growth is seized with forceps and the incision deepened with sharp-pointed scissors through the muscular wall of the bladder. The ureter should be included in the muscular tissue, and by dissection with the finger a pedicle is formed by the ureter. An incision is now made through the wall of the ureter beyond the growth and a fine thread of catgut is passed through. The ureter is then cut across completely and another suture passed through the wall opposite the first. The resection of the portion of the bladder-wall which bears the growth is now completed. The ureter is now drawn into the bladder by means of the two threads of fine catgut. With fine scissors the ureter is split so as to form right and left flaps. The threads of catgut are now passed through the whole thickness of the bladder-wall on each side of the lower end of the wound and tied. The remaining part of the vesical wound is closed with catgut sutures.

When it is impossible to find the orifice of the ureter and pass a catheter into it, a search for the ureter should be made after the growth has been removed, and it may be found in the perivesical fat. If it cannot be found, the part of the bladder wound at which the opening would naturally lie is left open. In one case in which this was done Albarran states that the patient made a good recovery, and an infundibuliform orifice discharging the urine could afterwards be seen with the cystoscope. If in such a case the ureter becomes narrowed so as to cause renal retention, a uretero-cystotomy can be practised.

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[1] *Médicine opératoire des voies urinaires,* 1909.

Results. Mortality. The immediate result of operation upon tumours of the bladder varies according to the character of the growth and the nature and extent of the operation which was performed.

By combining his own collection of cases[1] with that of Rafin[2] Watson obtained[3] 679 cases of operation upon tumours of the bladder. Of these 319 were for benign tumours, 334 for malignant tumours, and 26 for 'special varieties of neoplasms' (myxoma and cholesteatoma).

Suprapubic operations without resection of the bladder-wall were done in 319 benign tumours with a mortality of 11.0%. Of 334 malignant tumours operated upon there were 279 cases of carcinoma, of which 70 died, a mortality of 35%, and 55 cases of sarcoma, 23 of which died, a mortality of 43%. There were 4 deaths in 16 operations for myxoma (25%), and 1 death in 10 operations for cholesteatoma (10%).

Partial resection of the bladder in 96 cases of carcinoma resulted in 21 deaths (21.8%).

After-results. In 165 suprapubic operations without resection there was recurrence in 28.4% and non-recurrence after three years of just under 20% of benign tumours.

In 125 cases of malignant disease operated on by the suprapubic route without resection, 65% had recurrence within three years. In 4.8% there was no recurrence.

In 50 cases of partial resection of the bladder for carcinoma there was recurrence in 58% within three years, and 10% were free from recurrence.

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[1] *Annals of Surgery,* December, 1905, No. 6.

[2] *Rapp. et Informat. XI^e Session de l'Assoc. Franç. d'Urologie.* Paris, October, 1905.

[3] *Diseases and Surgery of the Genito-urinary System,* 1909.

CHAPTER X

CYSTECTOMY

GENERAL CONSIDERATIONS

Indications. Complete removal of the bladder has been performed in a few cases for very extensive development of papilloma, and in one case of tuberculosis and one of vesico-vaginal fistula.

The only indication that need be discussed, however, is malignant disease of the bladder. Before the question of cystectomy can be entertained, certain conditions must be fulfilled.

(1) The patient must have sufficient strength to undergo a very severe operation.

In the later stages of malignant disease of the bladder ascending pyelonephritis is a frequent complication. In other cases ureteral obstruction causes hydro- or pyonephritis. Failure of the renal function is likely to follow a severe operation in such cases.[1] Apart from renal complications death from exhaustion very frequently follows cystectomy if the patient be weak and cachectic.

(2) The growth must be confined to the bladder, *i.e.* there must be no sign of local spread beyond the bladder, and no evidence of metastatic deposit in glands and other organs. An exception to this restriction may be made in favour of the prostate, where cysto-prostatectomy is to be performed.

Choice of operation. The malignant growths that are confined to the bladder may be removed either by resection of a part of the bladder-wall or by removal of the whole bladder, and it will be necessary to choose between these two operations.

It is possible to remove completely a circumscribed malignant growth of the bladder by resection of the wall when the growth is situated at any part except on the trigone. Even where the growth has invaded the ureter on one side the duct may be transplanted to another part of the bladder and the infiltrated portion removed with the rest of the growth. Where, however, both ureters are involved and the base is infiltrated, resection of the bladder-wall will not suffice to remove the whole growth, and cystectomy must be performed. The same applies to cases where the growth has spread over a large area of the bladder-wall.

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[1] Author, *Renal Function in Urinary Surgery*, 1908.

Wherever it is possible, resection of the bladder-wall should be preferred to cystectomy, for the former carries an operative mortality of 22% (Enderlein and Walbaum[1]), while the latter operation is fatal in 61.5% of cases (Goldenberg[2]). With the increased accuracy of diagnosis by means of the cystoscope, bladder growths are discovered and their nature recognized at an earlier stage than hitherto. The cases suitable for resection will therefore proportionally increase in the future. Cystectomy should be reserved for the cases where resection of the bladder-wall is impossible.

Another point that will have to be decided before operation is whether the prostate and seminal vesicles should be removed with the bladder. When these organs are not actually invaded by the growth they may, according to some authorities, be left untouched. The operation of cysto-prostatectomy, when performed by the combined perineo-abdominal method, is not more difficult and does not seem to be more fatal than the removal of the bladder alone, and it possesses the great advantage of removing the prostate, which is very intimately connected with the bladder base and is frequently invaded by bladder growths in this region.

Treatment of the ureters. The efficient derivation of the urine is the most difficult problem which has to be faced in cystectomy. The dangers of this part of the operation are immediate and remote. The immediate dangers are shock and collapse from an operation prolonged by implantation of the ureters. The remote dangers are ascending septic inflammation of the kidneys, which is specially frequent where the implantation has been made into the bowel, and kinking of the ureters and stenosis of the new ureteral orifice in any implantation. The state of the patient at the end of the cystectomy in some cases has necessitated abandoning the ureters in the depth of the wound or fixing them in the suprapubic wound, and a few patients have recovered.

Watson[3] regards five out of fifteen deaths in twenty-five cases of cystectomy as directly due to ureteral implantation. He suggested the separation of the operation of derivation of the urine from that of removal of the bladder, and the use of nephrostomy as the means of draining the urine. Other surgeons have substituted ureterostomy in the two-stage operation.

The following figures show the results of operation in each of the methods:—

I. **Derivation of urine and removal of bladder at one operation.**
(1) *Ureters abandoned in the wound.* In 4 cases in which this occurred

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[1] *Festschrift z. 60. Geburtstage O. Ballinger's,* Wiesbaden, 1903.
[2] *Beitr. z. klin. Chir.,* vol. xliv, 1904.
[3] *Annals of Surgery,* vol. xlii, December, 1905.

(Bardenheuer, Kümmell, McCosh 2), 2 died, one from shock and another from uræmia, and 2 recovered and were well thirteen and fifteen months respectively after the operation.

(2) *Ureters fixed in the suprapubic wound.* In 6 cases (Wasilief, Harris, Woolsey [1 ureter in rectum], Bardenheuer 2, and Garré), 2 recovered from the operation, and 4 died. One patient died of shock and another of uræmia. One died two months after the operation from pneumonia, and another after an attempt to transplant the ureter from the wound into the urethra, while a third died of uræmia after several attempts had been made by plastic operations to create a new bladder. None of these deaths appear to be fairly attributable to the actual seat or method of implantation.

(3) *Implantation of ureters in the rectum.* In 13 cases of implantation of the ureters in the rectum after cystectomy for growths of the bladder, 8 died (Küster, Giordano, Turetta, Schede, Lund, Wendel, Wiljaminew, Krause), and 5 survived the operation (Tuffier, Chalot, Winiwarter, Krause, Carson). The deaths were due to shock from prolonged operation, 3; exacerbation of previously existing pyelitis, 1; ascending infection, 4. It will be seen here that about one-half of the deaths resulted from the extreme length of the operation, and the other half from ascending infection from the rectum. Of the patients that recovered, 1 died from unknown causes fourteen months after the operation (Tuffier), 1 had recently been operated on when the record was published (Carson), 1 was in good health three and a half months after the operation (Krause), and 1 was in good health and comparative comfort five years after the operation (Winiwarter). In none of these cases, however, was the implantation into the rectum successful, for a fistula formed and the urine passed by this.

(4) *Implantation of the ureters into the large intestine.* In a case of papilloma vesicæ, where Wilms[1] performed cystectomy, he successfully implanted the ureters in the sigmoid flexure of the colon. Six months after the operation, the patient voluntarily passed urine from the rectum every two or three hours, and once or twice at night.

Krönig[2] performed lumbar colotomy, and later removed a cancerous uterus and bladder and implanted the ureters in the rectum. Four months later the urine was clear.

After cystectomy Verhoogen[3] isolated the cæcum and implanted the ureters into it, making an opening at the abdominal wound. Two patients on whom he operated in this manner died.

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[1] Recorded by Jaeger, *Inaug. Diss.*, Leipzig, 1906.

[2] Quoted by Albarran, *loc. cit.*

[3] *Centralb. f. d. Krankh. der Harn- u. Sex. Org.*, 1895, vol. vi.

Albarran[1] quotes 6 fatal cases and 2 recoveries from implantation of the ureters in the large intestine by various surgeons.

(5) *Implantation of the ureters into the urethra.* Stimulated by Sonnenburg's[2] successful operation in ectopia vesicæ, several surgeons have attempted to implant the ureters in the urethra after cystectomy.

In 4 cases (Kayser, Lindner, Göpel, Bardenheuer), 3 died after the operation from shock, and the fourth from pyelonephritis, after an attempt to transplant the ureters from the abdominal wound into the urethra.

(6) *Implantation of the ureters in the vagina.* Of 7 cases where this operation was performed (Pawlik, Kossinski, Robson, Zeller, Mann 2, Lapthorne Smith), 3 died and 4 recovered. Shock accounted for 2 deaths, and ascending pyelonephritis for the third.

In Pawlik's[3] patient the vagina was converted into a receptacle which held 300 cubic centimetres of urine. The urethra was implanted in this, and voluntary micturition was established. The patient was well sixteen years after operation. In the other cases the functional result was not so fortunate, for no reservoir was formed and the urine leaked from the vagina.

II. **Derivation of the urine and removal of the bladder in two stages.** (1) *Implantation of the ureters in a wound in the loin.* In six cases of cystectomy for malignant disease the ureters were previously brought out on the loin and a permanent fistula established on each side (Albarran 1, Fenwick 2, Rovsing 3). All six patients recovered from the operation.

In one of Rovsing's[4] cases stenosis of the external orifice of the fistula occurred, and the same condition resulted in Albarran's[5] case and necessitated nephrectomy. One of Fenwick's[6] cases was well six months after the operation, and the second was a recent operation. The result in Rovsing's remaining cases is not stated.

(2) *Bilateral nephrostomy.* This operation was suggested by Watson,[7] who claimed that ureteral implantation performed for any reason had a mortality of 41.2%, and that 44.6% of the fatal cases were due to the ureteral implantation. If Maydl's operation of transplanting the bladder trigone with the ureters be excluded, as it cannot be done in

[1] *Méd. opératoire des voies urinaires,* 1909.

[2] *Verhandl. d. Deutsch. Gesellsch. f. Chir.,* 1885.

[3] *Wien. med. Wochensch.,* November 7, 1891.

[4] *Centralbl. f. Chir.,* 1907, No. 30, p. 873.

[5] *Loc. cit.*

[6] *Brit. Med. Journ.,* July 4, 1908.

[7] *Annals of Surgery,* vol. xlii, December, 1905.

growths of the bladder, the operative mortality rose to 50%, and half of the fatal cases were directly due to the ureteral implantation.

In 979 cases of nephrostomy, on the other hand, performed for various causes, the mortality was 15%, and the mortality in these cases was due to the disease for which the operation was done, and not to the actual operation.

Further, the fistulæ have been borne by patients for three, seven, and sixteen years without infection of the kidneys, and the patient is able by the aid of an easily adjusted apparatus to exist in comfort.

An interval of four to six weeks should elapse between the derivation of the urine and the removal of the bladder.

The following statements may be permitted in review of this difficult problem:—

1. A large part of the high operative mortality of cystectomy is due to the operation for derivation of the urine being performed at the same time as the removal of the bladder.
2. This part of the mortality is set aside if the two operations are performed separately with an interval of some weeks.
3. The methods of derivation of the urine which are specially suited for the two-stage operation in the male are lumbar nephrostomy and ureterostomy, and in the female subject vaginal implantation also.
4. When the complete operation is performed at one time, the best results have been obtained in female subjects from implantation of the ureters into the vagina.
5. Implantation of the ureters into the rectum is seldom successful, and in the majority of cases where the patient has survived the operation a fistula has formed by which the urine was discharged on the surface and not into the rectum.
6. Implantation of the ureters into the large intestine has not given encouraging results.
7. In surviving cases of implantation of the ureters into the bowel there is very grave danger of ascending septic inflammation.
8. Implantation of the ureters into the urethra has not given good results.
9. Fixation of the ureters in the suprapubic wound has been successful in several cases.
10. After ureterostomy there is considerable danger of stenosis of the outlet of the fistula, and of ascending septic inflammation.

The operation that is most likely to be successful is a two-stage operation, in which the first stage consists in derivation of the urine by vaginal implantation in the female and nephrostomy or ureterostomy in the male subject.

The second stage consists in the removal of the bladder, and if necessary the prostate and seminal vesicles.

The following operations will be described:—

(i) Cystectomy in the male.
(ii) Cysto-prostatectomy.
(iii) Cystectomy in the female.

CYSTECTOMY IN THE MALE

From four to six weeks previous to removal of the bladder some method of derivation of the urine should be carried out (see p. 655).

The combined perineo-abdominal method. The bladder is distended with ten or twelve ounces of fluid, and the pubic and perineal regions are prepared for operation.

The patient is placed in the lithotomy position, and a curved, transverse prerectal incision with the concavity forwards is made. A dissection similar to Zuckerkandl's method of exposing the posterior surface of the prostate for prostatectomy is carried out. The urethro-rectal muscle is cut across, and the space between the rectum and membranous urethra and prostate opened up. The separation is carried as high as possible, stripping the peritoneum off the seminal vesicles.

The extra-peritoneal method. The patient is now returned to the horizontal and then raised into the Trendelenburg position. A transverse suprapubic incision is made as for transverse cystotomy (see p. 625) and the bladder fully exposed.

If a suprapubic fistula be present from a previous cystotomy, this is dissected out, and the bladder explored to ascertain the extent of the growth. The cavity is then packed with gauze and the opening closed with forceps.

If no fistula exists Albarran recommends that the bladder should not be opened, as it is likely to infect the wound.

The peritoneum is now stripped up by blunt dissection to the apex of the bladder, and the separation continued along the posterior wall, using the fingers to peel the membrane off the distended organ.

If the peritoneum be found adherent at any spot so that it cannot be separated from the bladder-wall, it is incised and the wound extended with scissors round the adherent area. The omentum may be found adherent to the bladder, and a portion must be ligatured and cut away. The edges of the wound in the peritoneum are united with interrupted catgut sutures, and the stripping of the peritoneum recommenced. The separation is continued downwards until it meets the dissection which was made from the perineum. The vas deferens is separated from the wall of the bladder on each side, and the seminal vesicles detached and pushed backwards. The whole bladder is now dragged over to the left, and the right ureter and the large vessels which pass outwards below it to the side wall of the pelvis are isolated. The ureter is separated, ligatured, and cut across, the cut end being seared, as Albarran recommends, with the thermo-cautery. The vessels are clamped.

The bladder is now raised and turned over to the opposite side of the wound, and the remaining ureter and vessels on the right side are treated in the same manner.

The bladder is emptied of the distending fluid, if this has not been previously done, and the apex is seized with forceps and dragged upwards and backwards so as to expose the anterior surface of the union with the prostate.

Albarran recommends that forceps should be passed through the perineal wound from the perineum and the apex of the bladder seized and pulled backwards as if to drag it out of the perineal wound. The pubo-vesical bands are thus made tense, and are cut across.

Dissection is now carried transversely at the front of the base of the prostate where it joins the bladder, and the neck of the bladder where it joins the prostatic urethra is cut across. Tuffier advised the use of the thermo-cautery for this part of the procedure, and seared the mucous membrane of the prostatic urethra in order to reduce the danger of infection from the septic bladder. A clamp is placed on the opening in the bladder. The trigone is dissected off the upper surface of the prostate and removed.

The surgeon now returns to the lateral pedicles which were clamped and set aside; each is ligatured with a single ligature, or the vessels are dissected and ligatured separately. A large rubber tube is placed in the suprapubic wound and another in the perineum.

The abdominal wound is carefully closed (see p. 626).

The intraperitoneal method. Wilms and others have opened the peritoneum transversely at the apex of the bladder without attempting to strip the membrane up. Watson claimed that much greater thoroughness is ensured by the exposure of the bladder in this way. He suggested that the peritoneum should be opened transversely at the apex of the bladder, and that the peritoneum lying upon the posterior surface of the bladder should be incised in its whole length and dissected up until the ureters are reached. If any part of the peritoneum be involved in the process it should be left adherent to the bladder. At the end of the operation the peritoneal wound is closed.

CYSTO-PROSTATECTOMY

Preliminary derivation of the urine is performed as in cystectomy.

The bladder is distended with fluid and the patient placed in the lithotomy position. A curved prerectal incision is made as if for perineal prostatectomy.

The prostate is now completely separated as if for extirpation of the whole prostate and its sheath.

The membranous urethra is cut across at the apex of the prostate and the anterior surface of the prostate separated from the back of the pubic bones.

The patient is now placed in the Trendelenburg position, and the bladder exposed by a transverse suprapubic incision. The peritoneum is stripped off the bladder as described in cystectomy, and the ureters and vessels ligatured on either side. The dissection which was made from the perineum is now reached. The bladder is drawn upwards and backwards, and the pubo-vesical ligaments are cut across. The bladder and prostate are now free, and are removed through the suprapubic opening.

Suprapubic and perineal drainage are established, and the abdominal wall carefully repaired.

VARIATIONS IN THE METHODS OF PERFORMING CYSTECTOMY AND CYSTO-PROSTATECTOMY

The combined suprapubic and perineal operation was first used by Küster,[1] and has been adopted by Göpel,[2] Wendel,[3] Watson, Albarran, and others. Removal of the bladder only or the bladder and prostate has been carried out by many surgeons by the suprapubic route alone.

Rovsing uses the suprapubic route and dissects down behind the bladder, and then behind the prostate, in performing cysto-prostatectomy.

A vertical suprapubic incision with partial section of the recti muscles has been used by some surgeons. Carson [4] made a vertical incision and detached the right rectus muscle from the pubic bone. A transverse suprapubic incision with a vertical incision in the middle line was used by Tuffier [5] and Wilms.

Albarran [6] and Hogge [7] performed symphysiotomy in order to obtain more space. In regard to this procedure, Albarran says that it has the disadvantage of necessitating a buried metal suture in a wound which is liable to be infected, a strong binder is necessary, and there is a danger of non-union of the pubic bones. Küster, Turetta, Schuchardt, and others made a partial resection of the pubic bones (see p. 628), but this gives less room.

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[1] *Volkmann's Sammlung,* 1886, p. 2335.

[2] *Schmidt's Jahrbücher,* 1898.

[3] *Beitr. z. klin. Chir.,* 1898.

[4] *Trans. Amer. Surg. Assoc.,* 1905, vol. xxiii, p. 269.

[5] *Rev. de. Chir.,* 1898, p. 277.

[6] *Les tumeurs de la vessie,* 1891.

[7] *Annales des maladies des organes génito-urinaires,* 1902, p. 375.

Where cystectomy alone is performed, some variations in the method of removing the bladder from the prostate and urethra have been practised. Watson suggested that if the prostate and vesicles were healthy, the bladder should be cut across transversely between two ligatures, and the divided edges of the lower portion might be sutured over the base of the prostate. Tuffier recommended the section of the vesical neck over a curved clamp on account of the possibility of trouble with venous hæmorrhage. Rovsing follows this method and leaves the clamp in place.

These methods ignore the fact that cystectomy is performed in most cases for a growth which is situated at the base of the bladder, and some portion of the growth is likely to be left behind with the trigone.

CYSTECTOMY IN THE FEMALE

An operation similar to that described for the male subject may be done, a vaginal incision replacing the perineal.

Pawlik[1] performed the following operation on a woman aged fifty-seven:

He introduced a metal sound into each ureter, and exposed the ducts in the anterior wall of the vagina. An incision 1 centimetre long was made in each ureter, and the edges of the wound stitched to the upper part of the incision in the vagina. The ureters were cut across below this. A catheter was placed in each ureter, and retained for several days. The openings of the ureters in the vagina were kept dilated by the passage of fine bougies.

Twenty-four days later the bladder was distended with fluid and exposed by a vertical suprapubic incision, and the peritoneum stripped off the posterior surface, the dissection being carried as far as the urethra. The fluid was withdrawn from the bladder, and the suprapubic wound packed.

A vaginal incision was then made immediately above the urethra, and the bladder, which had previously been isolated through the suprapubic wound, was delivered into the vagina. The deepest part of the urethra was then cut across and the bladder completely removed through the vagina. Catheters were placed in the ureters and brought out of the urethra, and the cut end of the urethra was sutured so that the anterior wall was attached to the anterior wall of the vagina and the posterior wall to the posterior wall of the vagina. The vagina was thus made to replace the bladder. The outlet of the vagina was closed by a second operation, and the new reservoir held 400 cubic centimetres, and could be spontaneously emptied by contraction of the perineal muscles.

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[1] *Wien. med. Wochenschr.*, Nov. 7, 1891.

Results. Jaeger[1] collected 31 cases of cystectomy, but 2 of them (Nos. 21 and 28) appear to be different reports of the same case, and one is therefore omitted here.

To the 30 cases thus left there may be added those of Schede,[2] Woolsey,[3] Kayser,[4] McCosh,[5] Tully Vaughan,[6] Fenwick 2,[7] and Carson,[8] 39 cases in all. Of these 22 were male and 12 female, and in 5 the sex was not stated.

Death followed immediately or soon after the operation in 18 cases, and 21 survived. The operation mortality was thus 46.1%.

Of the fatal cases 6 were stated to be due to shock and collapse, and most of them may fairly be attributed to the length of the operation due to the time taken in implanting the ureters in the bowel or elsewhere. With the two-stage operation suggested by Watson a large proportion, if not all, of this part of the mortality figures may be set aside. Disease of the kidneys was the cause of 6 deaths. In 3 of these the patient died of uræmia, which immediately followed the operation, and was probably due to pre-existing disease of the kidneys. In one case where suppurative pyelitis led to a fatal result, the renal disease was present before the operation. Ascending inflammation of the kidneys following immediately on the operation was the cause of death in 2 cases. One patient died of pneumonia.

In 4 of the fatal cases metastatic deposits were found in the abdominal glands, kidneys, lungs, or elsewhere, so that the patient could not have long survived had he recovered from the operation.

Twenty-one patients survived the operation, but one patient (Bardenheuer) died from the effects of a second operation performed eight days later with the object of transplanting the ureters from the skin wound into the rectum. Another (Woolsey) died three and a half months after the cystectomy from ascending infection of the kidneys. Another (Tuffier) died fourteen months after operation from unknown

[1] *Loc. cit.*

[2] *Annales des maladies des organes génito-urinaires,* 1903.

[3] *Annals of Surgery,* 1903, vol. xxxviii, p. 445.

[4] *Hygiea,* Stockholm, 1903, 362.

[5] Quoted by Watson, *Annals of Surgery,* vol. xlii, December, 1905.

[6] Quoted by Watson, *loc. cit.*

[7] *Loc. cit.*

[8] *Loc. cit.*

causes, and a fourth died thirteen months after the operation from uræmia which resulted from double pyonephrosis.

Of the remaining 17 cases I could obtain no further information in regard to 5 (Bursa,[1] Wendelenburg,[2] Modlinski,[3] Mann 2[4]), and 2 (Fenwick, Carson) were still under treatment at the time of publication.

The following table shows the condition of the remaining 10 cases reported at varying periods after the operation:—

No.	*Operator.*	*Time since operation.*	*Ureter implantation.*	*State when last reported.*
1	Kümmel[5] (vesico-vaginal fistula)	?	Rectum	Retains urine in rectum 4 hours.
2	Krause[6]	3½ months	Sigmoid flexure	Good health. Holds urine 5–6 hours.
3	Wilms	6 months	Sigmoid flexure	Holds urine 2–3 hours.
4	Fenwick	6 months	Skin of loin	Well. Wears apparatus.
5	Wassiljew[7]	7 months	Suprapubic wound	Well. Apparatus.
6	Hartley[8] (tuberculosis)	7 months	Rectum	Well. Holds urine 3–4 hours during day and passes it once or twice at night.
7	McCosh	13 months	Abandoned in wound. Suprapubic fistula.	Well. Leads active life.
8	McCosh	15 months	Abandoned in wound. Suprapubic fistula.	Well. Leads active life.
9	Hogge	5 years	Rectum, perineal fistula formed, one ureter successfully transplanted into rectum a year later.	Well. Perineal fistula.
10	Pawlik	16 years	Vagina	Continent. Voluntary evacuation of 300 c.c. of urine.

In reviewing these results it will be seen that the selection of patients for the operation was not always fortunate, for in a certain number metastatic deposits had already formed, and in others the kidneys were so far diseased as to be the cause of a fatal result. The large mortality due to prolonged operation at one sitting will in the future be much reduced by the two-stage operation. The danger of ascending pyelonephritis is less in vaginal implantation than in implantation of the ureters into the bowel. A fistula of the ureter or renal pelvis on the surface of the body, whether perineal, suprapubic, or on the loin, has shown less danger from ascending septic inflammation than one opening into the bowel.

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[1] *Thèse de Paris,* 1896.

[2] *Centralbl. f. Chir.,* 1895, p. 117.

[3] *Berichte über die Verhandl. der deutsch. Gesellsch. f. Chir.,* 1899, p. 143.

[4] *Buffalo Med. Journ.,* July, 1901.

[5] *Berl. Klinik,* H. 59, 1893.

[6] *Deutsche med. Wochenschr.,* 1900, M 12.

[7] *Russki. Chirurg. Archiv,* 1895, H. 4.

[8] *Medicine,* 1903, vol. lxxxiii, p. 385.

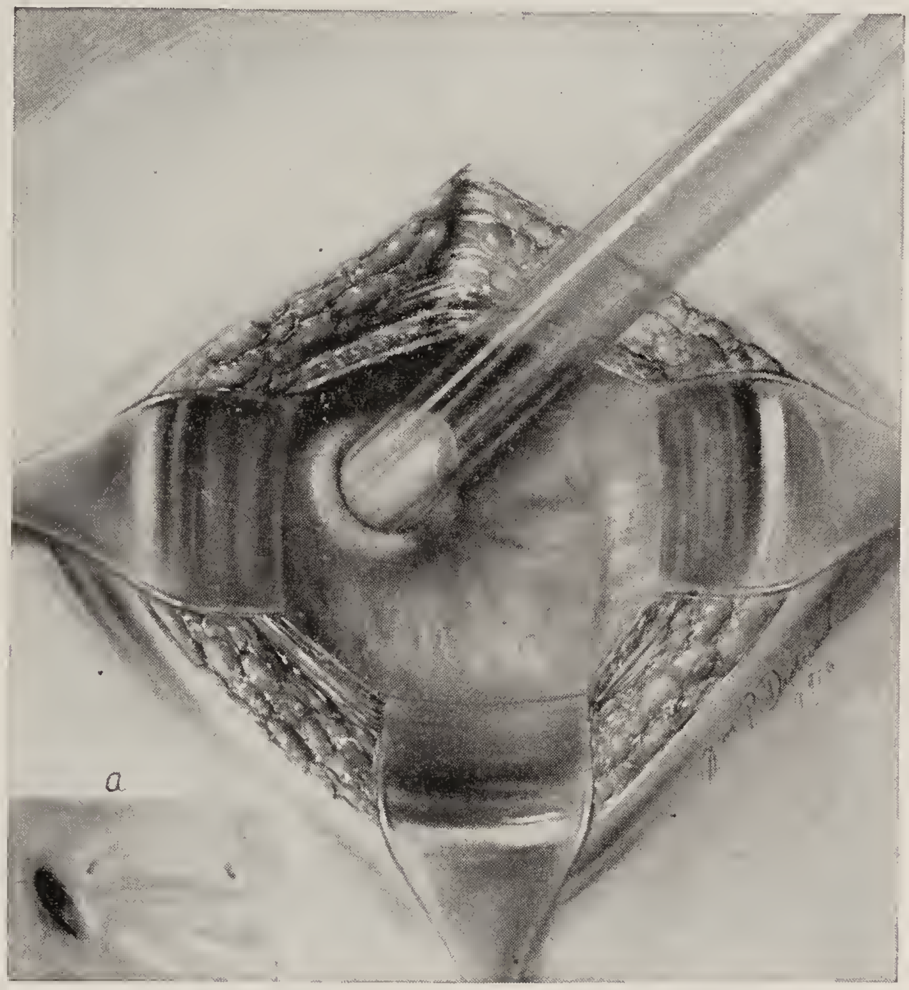

FIG. 340. THE MUCOSA OF THE DIVERTICULUM MAY BE SEEN BEING DRAWN UP INTO THE GLASS SUCTION TUBE. Insert *a* shows diverticular orifice before insertion of tube. In this drawing, as in the following six, the symphysis pubis is shown uppermost. (*Young.*)

In only two of the surviving cases (Hogge and Pawlik) has sufficient time elapsed to permit of their being regarded as cures of malignant disease, and as having escaped for a reasonably long time the danger of ascending inflammation of the kidneys.

EXCISION OF VESICAL DIVERTICULA (YOUNG'S OPERATION)

Young describes his operation as follows:—

'The first intravesical method which I employed was as follows: After dilatation of the diverticular orifice, a circular incison was made

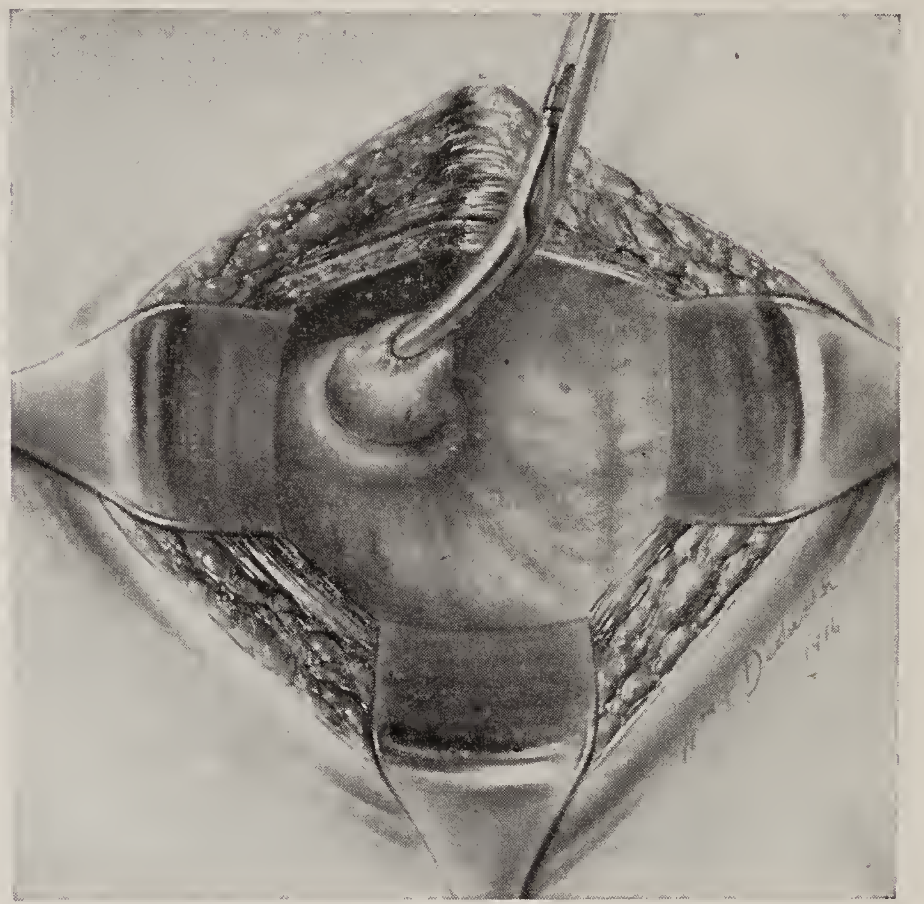

Fig. 341. After Removal of the Suction Tube, which has inverted the Diverticulum, the Mucosa is grasped with Forceps. (*Young.*)

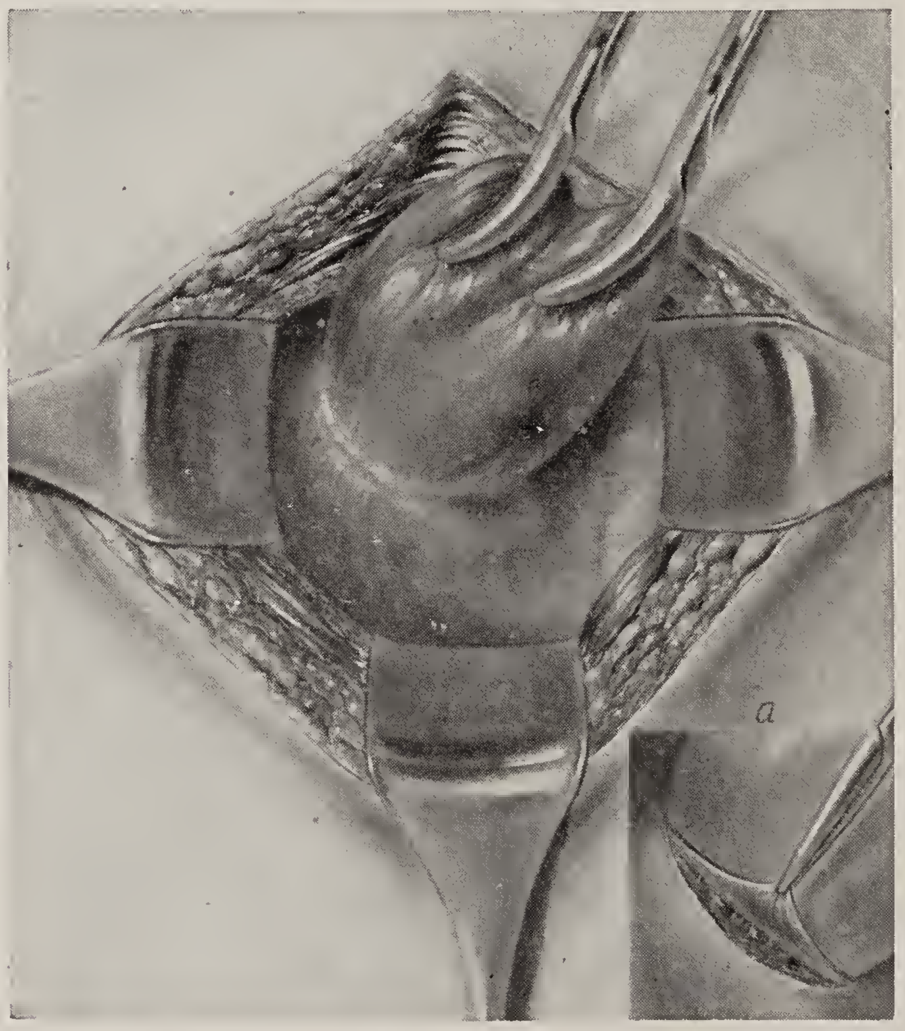

Fig. 342. The Intravesical Delivery of the Diverticulum has been completed by the use of Clamps, making Traction at Various Points around the Circumference. Insert *a* shows a circular incision around neck of diverticulum and beginning elevation of the mucosa. (*Young.*)

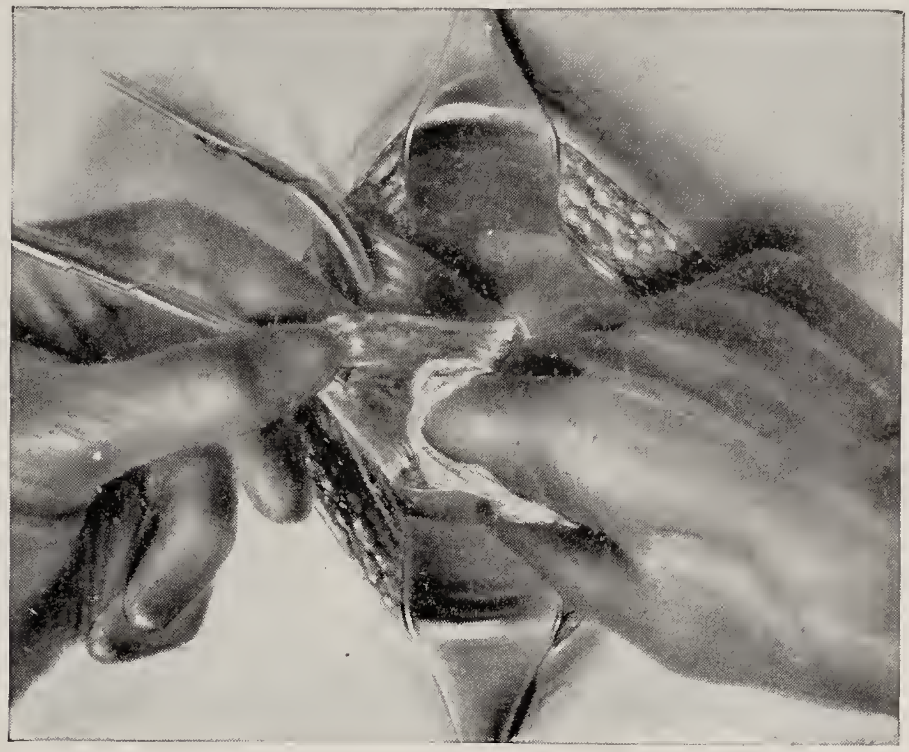

Fig. 343. A Circular Incision has been made through the Mucosa at the Neck of the Diverticulum, the Mucosa elevated at One Point, and Blunt Dissection begun, peeling out the Lining Membrane of the Diverticulum. (*Young.*)

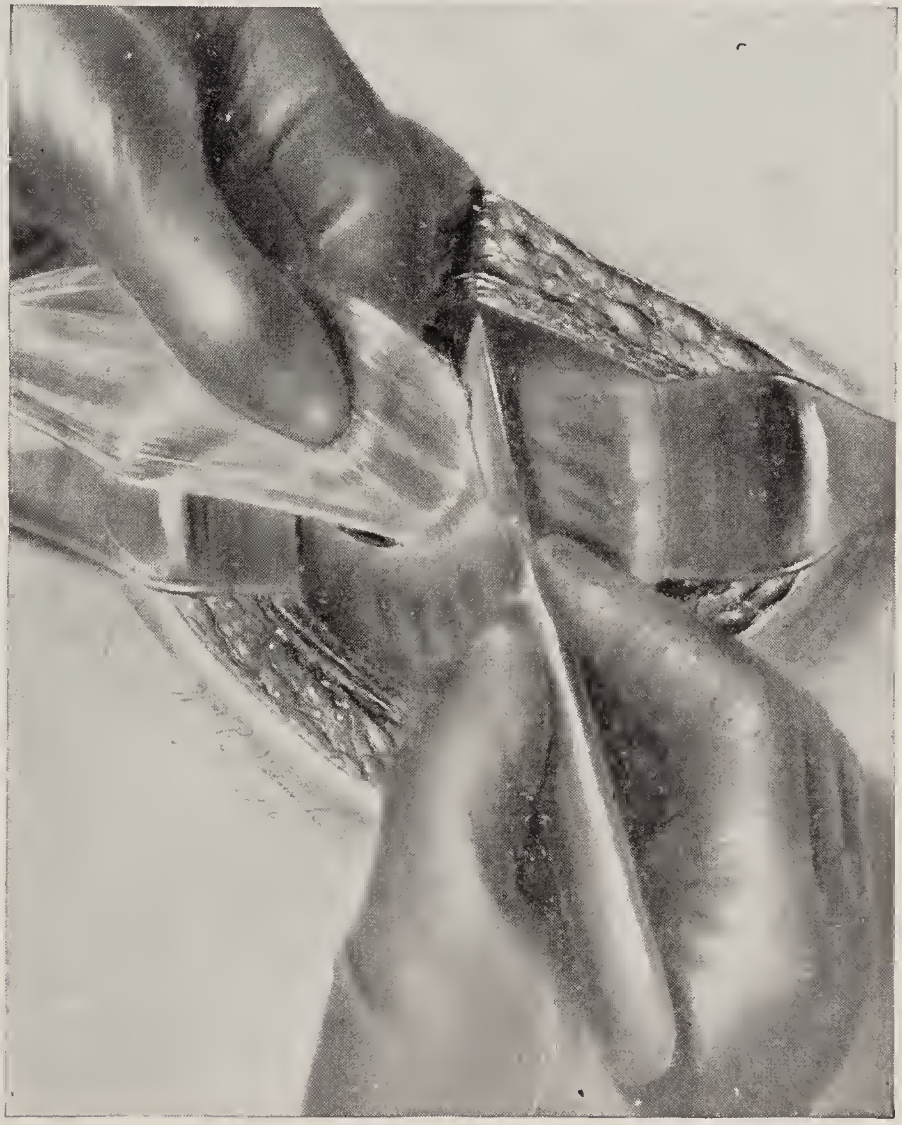

Fig. 344. The Entire Mucous Lining of the Diverticulum has been peeled away from the Underlying Tissues, and the Last Attachment of Diverticular Mucosa to Vesical Mucosa is being divided. (*Young.*)

through the mucous membrane around the opening, the diverticular mucous membrane being grasped with the hæmorrhoidal forceps, gradually drawn outward, and excised. In some cases it was possible to grasp the diverticulum with forceps, invaginate it either by traction upon the forceps or with a finger outside of the bladder assisting in the invagination, and, after it had been turned inside out within the bladder, to complete its excision. In large and very deep-seated adherent cases, however, neither of these methods was found suitable, and I therefore adopted the following technique.

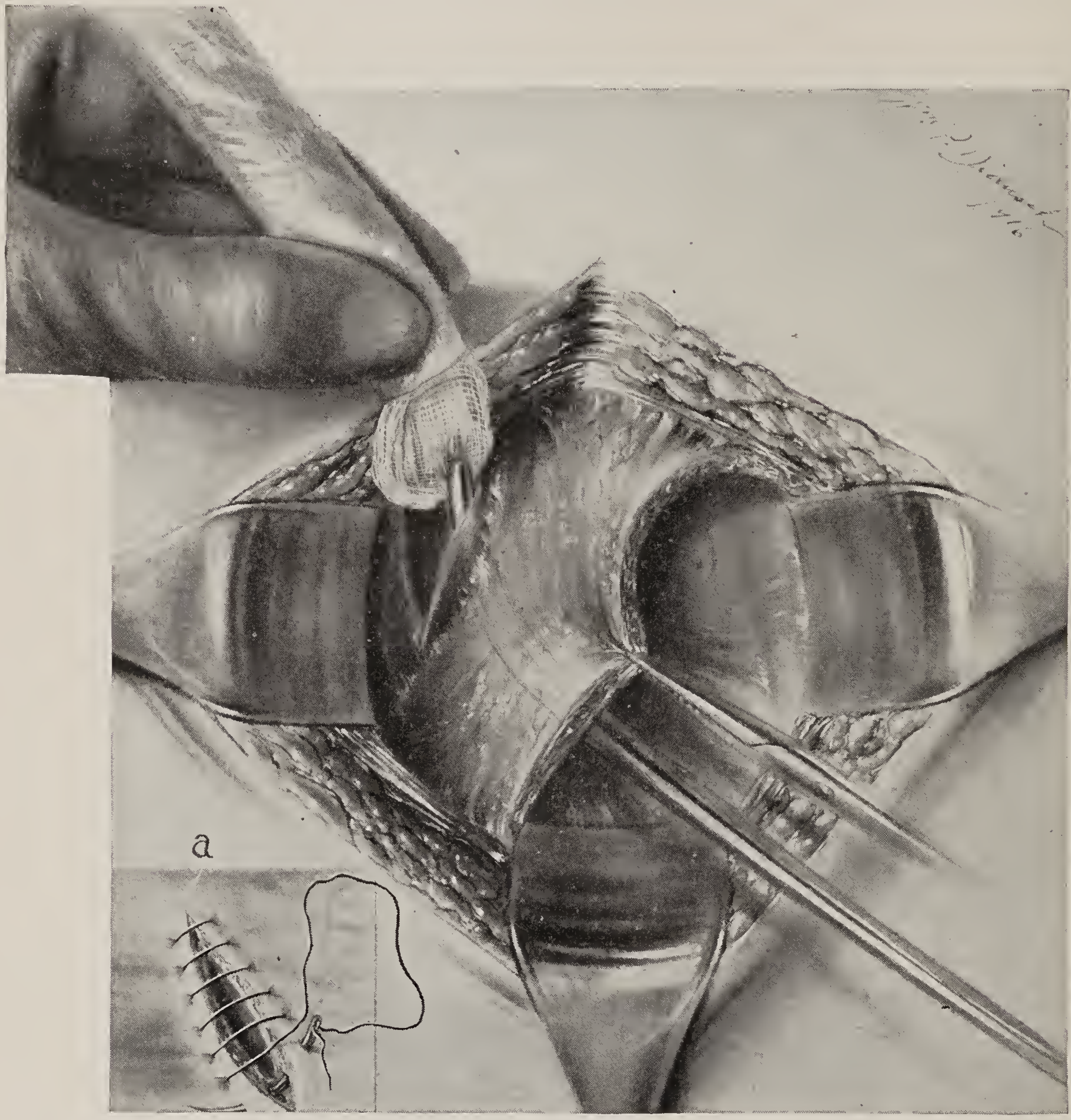

Fig. 345. The Site of the Diverticulum is drained extravesically by means of a Cigarette Drain carried down lateral to the Bladder. The bladder mucosa is then closed with a continuous catgut suture, as shown in insert *a*. (*Young.*)

'Invagination of diverticulum by suction and traction; intravesical enucleation of the sac of mucosa, thus entirely avoiding sharp dissection, and pushing the ureter (if present) back into the bladder; intravesical closure; extravesical drainage of region of diverticulum; plastic operation, punch, or prostatectomy, to cure obstructive cause of diverticulum.

'This method is so well shown in the accompanying illustrations that hardly any further description is necessary. The diverticular orifice is investigated, and if necessary dilated with forceps. Into this orifice a glass tube is inserted to the full depth of the diverticulum, and immediate suction with an electric air pump is commenced. It is usually evident, almost at once, that the mucous membrane has been drawn against the orifice, and the tube is then drawn very slowly outward, a small distance, the suction being continued until the mucous membrane of the diverticulum is seen coming upward inside of the glass tube (see Fig. 340). Not infrequently the mucous membrane reaches a point 1½ to 2 inches above the bottom of the tube. The glass tube is then slowly drawn out, bringing the diverticular mucosa with it, and as soon as the end of the tube is outside of the diverticular orifice, the mucous membrane is caught with a toothed clamp (see Fig. 341), and

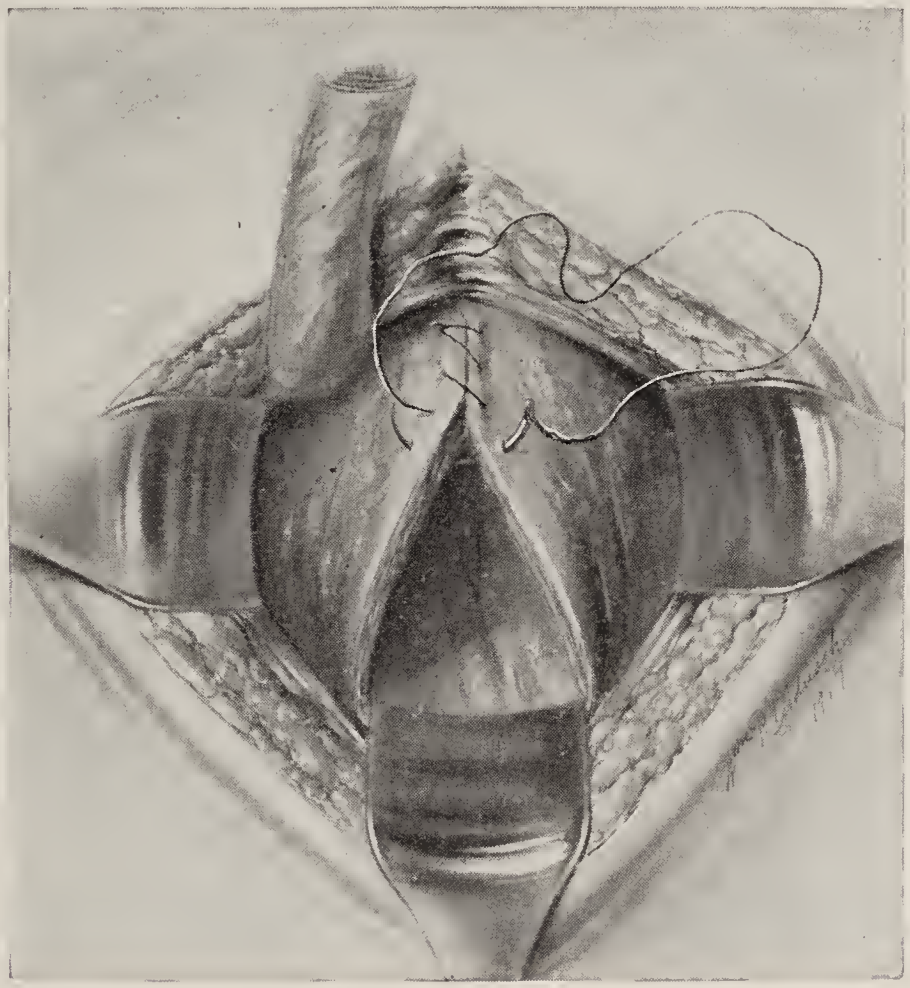

FIG. 346. AFTER PLACING EXTRAVESICAL DRAIN, MIDLINE INCISION IN BLADDER IS CLOSED WITH CONTINUOUS CATGUT. (*Young.*)

the glass tube then removed. The intravesical delivery of the diverticulum is then completed by traction, the operator using sharp-toothed clamps applied at various points around the circumference, and then possibly further dilating the diverticular orifice in case the sac is very large and difficulty is experienced in delivering the whole diverticulum through the small orifice (see Fig. 342). As soon as the entire diverticulum has been turned inside out within the bladder, a circular incision is made through the mucous membrane around the neck of the diverticulum and the mucous membrane elevated at one point (insert *a,* Fig. 342). Then, by blunt dissection, it is a simple matter to peel away and remove in one piece the entire lining membrane of the diverticular sac, the excised tissue consisting merely of mucosa and submucosa. In separating the sac and peeling it out (see Figs. 343 and 344), the operator dissects with gauze on the finger, pushing down all underlying structures, thus avoiding hæmorrhage and eliminating the danger of injury to the ureter. If the ureter comes into view, it is pushed back, only the thin membrane being removed. The method of extravesical drainage is shown in Figs. 345 and 346. A cigarette drain is carried down extravesically and lateral to the bladder until it reaches the collapsed cavity from which the diverticulum has been removed, and the orifice of the diverticulum in the bladder is then closed as shown in insert *a,* Fig. 345. The drawing shows a curved clamp passing into the bladder through the diverticular orifice, into the cavity from which the diverticulum has been removed, and out again laterally and extravesically, pulling the cigarette drain in place. The bladder incision is then closed around a rubber drainage tube, or closed tightly, leaving a retention catheter in place.'

CHAPTER XI

OPERATIONS FOR ECTOPIA VESICÆ

A LARGE number of operations have been suggested and practised for ectopia vesicæ. The following are the chief types:—

- I. The formation of a reservoir in the body.
  - A. The bladder.
    - 1. Closure of the defect by osteoplastic operations.
    - 2. Closure of the defect by flaps.
      - (*a*) Autoplastic methods.
        - (i) Of skin.
        - (ii) Of intestine.
      - (*b*) Heteroplastic methods.
  - B. Rectum.
    - 1. By transplantation of ureters.
    - 2. By vesico-rectal fistula.
  - C. Sigmoid flexure.
  - D. Vagina.
- II. No reservoir formed in the body.
    - 1. Implantation of ureters.
      - (*a*) In urethra.
      - (*b*) In skin.
    - 2. Nephrostomy.

Trendelenburg's operation.[1] This consists in opening the sacro-iliac synchondrosis, which allows of the approximation of the separated pubic bones, and subsequent closing of the defect in the bladder-wall. The patient is placed in the prone position and a longitudinal incision made over one sacro-iliac synchondrosis. The posterior ligaments of the synchondrosis are cut through and lateral pressure applied to the iliac bone. This ruptures the deeper fibres and allows the pubic bone to swing towards the middle line. A similar operation is performed on the opposite side. The patient is placed on a special couch. Round the pelvis is passed a leather girdle, the ends of which cross in front, and are attached to cords and weights acting over pulleys on each side.

The pelvic bones are fixed in the new position for some weeks, and during this time some form of apparatus must be applied to remove the urine. Three or four months after the first operation closure of the bladder is attempted. The mucous membrane is dissected up at its junction with the skin, and the bladder-wall raised along this line and the edges brought together. Over this the recti muscles and skin are sutured in the middle line. When the bladder has been successfully closed, an attempt may be made to reconstruct the urethra.

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[1] *Centralbl. f. Chir.*, vol. xlix, December, 1885; *Annals of Surgery*, vol. xlii, 1906, p. 281.

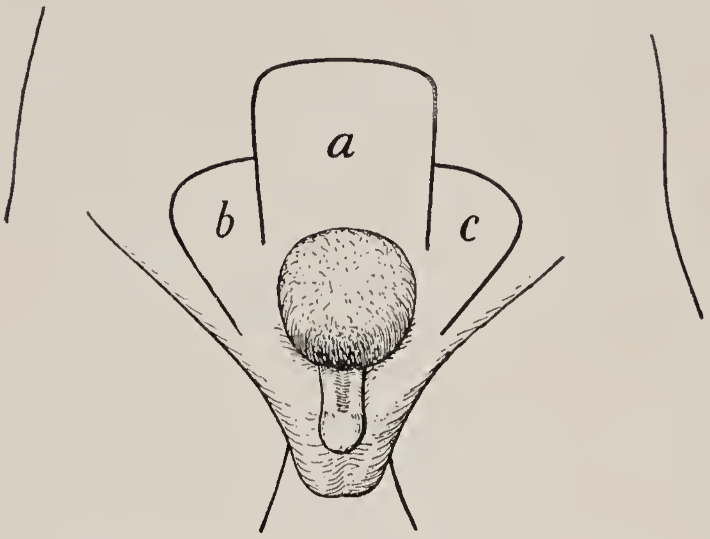

Fig. 347. Wood's Operation for Ectopia Vesicæ. *First stage.* *a,* Median flap; *b, c,* lateral flaps.

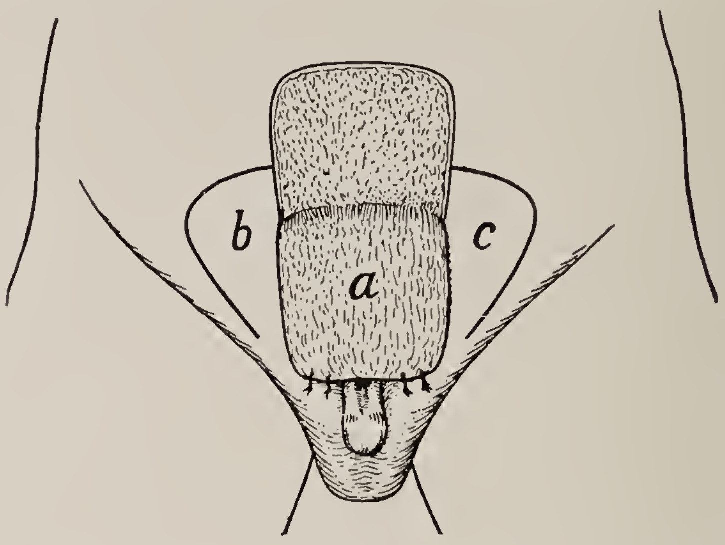

Fig. 348. Wood's Operation for Ectopia Vesicæ. *Second stage.* Median flap, *a,* turned down over the vesical defect.

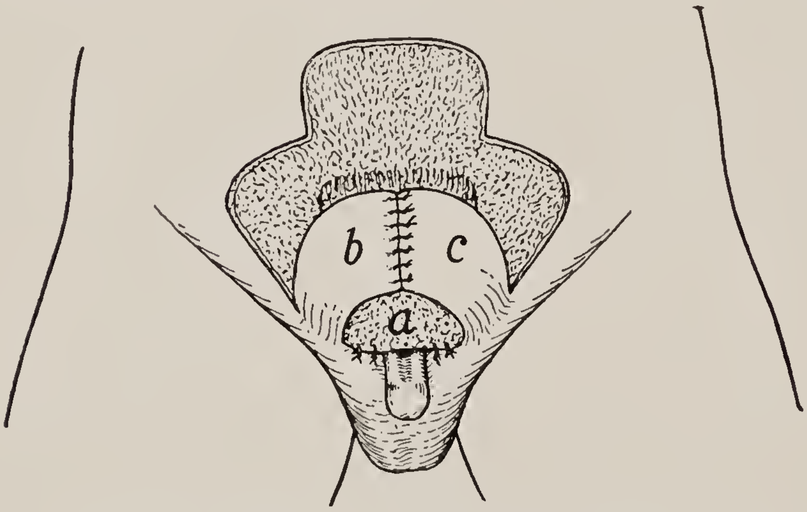

Fig. 349. Wood's Operation for Ectopia Vesicæ. *Third stage.* Lateral flaps, *b, c,* turned over the median flap, *a.*

Wood's operation. This operation consists in closure of the vesical defect by means of skin flaps, and should be performed about the age of four or five years. Several operations are usually required, and they should be completed before puberty, when hairs grow upon the skin flap and erections of the penis interfere with the operation.

If puberty be already passed, some means should be adopted to remove the pubic hairs.

Three flaps are used in the operation, one from the abdominal wall above the bladder, which is turned over with the skin surface inwards, and one flap from each side, which covers the first flap.

The median superior flap has a narrow base at the upper margin of the defect, and a broad expansion at its upper part in the region of the umbilicus (see Fig. 347). The length and breadth must be rather more than sufficient to cover in the gap which exposes the bladder defect. From the centre of each side of the superior flap an incision commences which outlines the lateral flaps. This is carried outwards and sweeps round an oval area at the side of the defect in the bladder. The base of each lateral flap is at its lower end and carries the superficial epigastric and external pudic arteries. The inner border of the flap passes along the margin of the exposed mucous membrane and on to the lateral surface of the penis. The flaps contain skin and as much tissue as is considered safe to remove without weakening the abdominal wall. The median flap is turned down and stitched over the gap, so that the skin surface forms the anterior wall of the bladder (see Fig. 348). The lateral flaps are raised and twisted inwards, so that they meet in the middle line and cover the exposed under surface of the median flap (see Fig. 349). The trefoil surface thus laid bare is either covered in at once by skin grafts or allowed to granulate and grafted later.

Implantation of the ureters in the rectum. Fowler[1] introduced a method of implantation of the ureters in the rectum in which he endeavoured to preserve them from contact with the fæces. He cut the ureters obliquely and formed a flap valve of mucous membrane from the anterior wall of the rectum. To the under surface of this he attached the cut end of the ureters, so that the descending fæces would press upon the valve and close the ureteric orifices. In closing the rectal wound the ureters were made to lie for a considerable distance between the mucous and the muscular coats of the bowel.

A boy of six years operated on in this manner was well two years later, and passed urine from the rectum every three hours. For the details of this and the succeeding method the reader is referred to the original articles.

Gersuny[2] made an artificial anus at the sigmoid flexure, and closed the upper end of the rectum. He then transplanted the ureters into the rectum.

Peters introduced catheters into the ureters and dissected them from the bladder, leaving a collar of the mucous membrane round the orifice of each. An incision was made in the perineum and the anterior wall of the rectum exposed. Two small openings were made through the rectal wall, and the catheters and ureters drawn through into the rectal cavity. Each ureter projected about 3 centimetres into the cavity. They were not fixed, and adhesions formed in three days, when the catheters were removed.

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[1] *Amer. Journ. of the Medical Sciences,* 1898, vol. cxv, p. 270.

[2] *Wien. klin. Wochenschr.,* 1898, No. 43.

Soubottine's operation.[1] An incision is made from the anus to the base of the coccyx, and this bone is excised. The posterior wall of the rectum is then slit up longitudinally, cutting through the anal sphincter. An incision is made through the anterior wall of the rectum and the posterior wall of the bladder, and a fistula created in this situation by suturing the edges of the wound. A horseshoe incision with the convexity upwards is now made round the vesico-rectal fistula, and including about one-third of the circumference of the rectal wall. The limbs of the horseshoe pass down to the skin at the anus. The portion of the rectal wall included in this horseshoe incision is now formed into a reservoir resembling an inverted bottle by stitching the edges carefully together. Finally, the rectal wall is united over this, and the wound in the posterior wall of the rectum closed and the anal sphincter repaired. A receptacle is thus formed of rectal mucous membrane in which the urine may collect without contamination by the contents of the rectum. The neck of the receptacle is in the grasp of the anal sphincter, so that continence is assured.

At the time of the operation, or after an interval, the suprapubic gap in the bladder is closed by a skin-flap operation leaving an opening at the lower part of the bladder, which is closed later.

In one patient operated in this manner, Soubottine obtained complete continence, and the urine was retained for four hours.

Maydl's operation.[2] In this operation the trigone of the bladder, together with the ureteric openings, is transplanted into the sigmoid flexure of the colon.

A catheter is introduced into each ureter. The abdominal wall is incised at the junction of the mucous membrane of the bladder and the skin at the upper margin of the defect. Two fingers of the left hand are introduced into the peritoneal cavity to act as a guide. The incision is carried round the whole circumference of the bladder to the edge of the urethral gutter (see Fig. 350). If one of the ureters opens near the skin a portion of the skin must be removed with it.

Having separated the bladder from the abdominal wall the urethra is cut across immediately above the orifices of the ejaculatory ducts. The ureters are now very carefully separated in the lower part of their pelvic course, taking care not to interfere with the blood-vessels which supply them. The bladder-wall is then cut away, leaving an oval area on which the ureters open. The peritoneum is cut more widely than the mucous membrane, so that a border of peritoneum overlaps the muscular tissue. The abdominal wound is now extended upwards in the middle line, and the sigmoid flexure of the colon brought out. A knuckle of this is isolated with bowel clamps. This loop is incised longitudinally along its free border, and the wound held open with forceps. The flap of bladder-wall with the ureteral orifices is fitted into the opening in the intestine by twisting it round (see Fig. 351). The mucous membrane, muscle, and peritoneum are now united to those of the bowel by successive rows of catgut sutures.

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[1] Wratsch, 1901. [2] *Wien. med. Wochenschr.*, 1896, vol. xlvii.

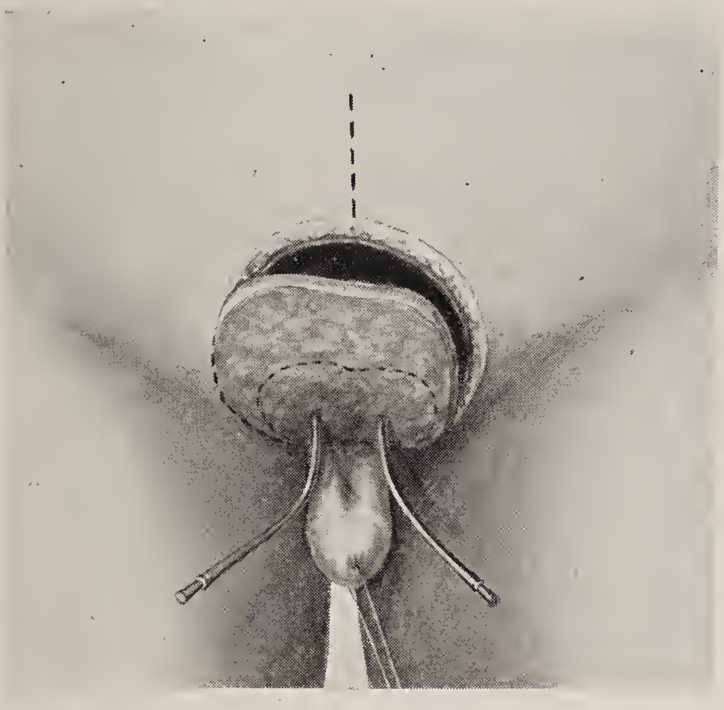

FIG. 350. MAYDL'S OPERATION FOR ECTOPIA VESICÆ. *First stage.* Isolation of the bladder. The oval portion of bladder-wall within the dotted line is preserved, the remaining portion is cut away.

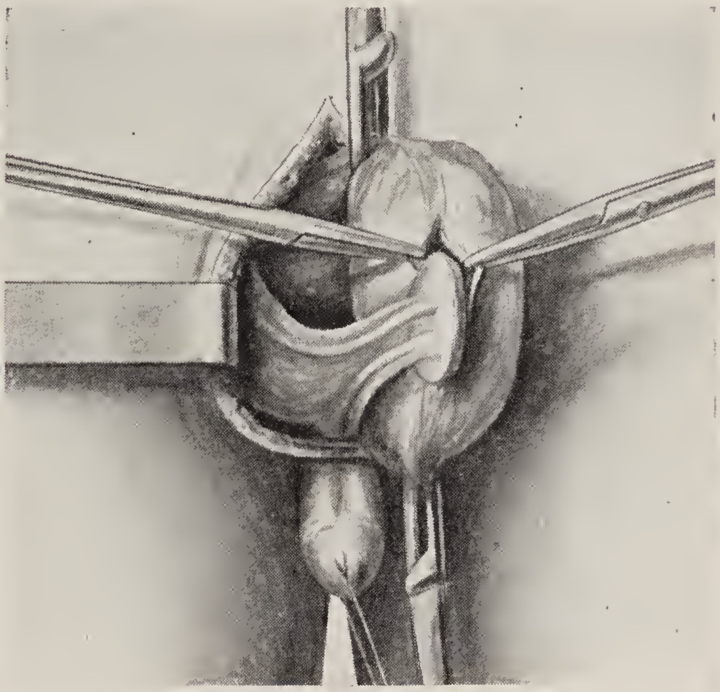

FIG. 351. MAYDL'S OPERATION FOR ECTOPIA VESICÆ. *Second stage.* Implantation of the bladder base with the ureteral orifices in the sigmoid flexure.

Sonnenburg's operation. Sonnenburg[1] implanted the ureters in the urethra after excision of the bladder in several cases of ectopia. An incision is made at the junction of the skin and mucous membrane, and the bladder dissected up without opening the peritoneum. The ureters are cut across and the bladder removed. The ureters are brought up to the surface and stitched to the edge of the urethral gutter. The abdominal wound is now closed. Where the ureteral orifices are not widely separated, and the mucous membrane is in good condition, Sonnenburg leaves the trigone and extirpates the remaining portion of the bladder.

Difficulties, dangers, and results of these operations. Trendelenburg's operation is designed to allow the edges of the deficient abdominal wall to come together so that a bladder might be formed of vesical mucous membrane alone.

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[1] *Verhandl. d. deutsch. Gesellsch. f. Chir.*, 1895; Ref. *Centralbl. f. Chir.*, 1895, p. 117.

The objection to these operations is that, even where they are successful, there is no sphincter to the new bladder. The patient is therefore incontinent, and apparatus must be worn.

In twenty-five cases collected by Katz, three were stated to have the power of retention of urine. The mortality of the operation was 22%.

Implantation of the ureters into the bowel may be immediately followed by general peritonitis from giving way of the line of union. To obviate this, Maydl recommends that the intestine should be fixed in the wound. Peterson found an operative mortality of 32% in twenty-eight cases of uretero-intestinal implantation.

When the union is successful there is a serious danger of ascending pyelonephritis. The ingenious methods of Frank and Soubottine are designed to prevent this. The method which has proved must successful in avoiding the occurrence of ascending pyelonephritis is that of Maydl, where the trigone is transplanted with the ureters, so that the natural openings are preserved. If larger portions of the bladder be transplanted into the bowel, the risk of sloughing from want of blood-supply is increased.

Stenosis of the new opening when the ureters only are implanted, and kinking of the ducts in any of the operations, are further dangers.

The following statistics show the immediate mortality of Maydl's operation:

Collector.	*Number of cases.*	*Number of deaths.*	*Mortality per cent.*
Peterson[1]	36	5	13.8
Bransford Lewis[2] .	22	3	13.6
Katz[3]	57	15	26.7
Orloff[4]	56	11	19.8
Hartley[5]	46	7	15.0
Watson[6]	42	9	21.4
Mazel[7]	14	2	14.3
Josserand[8]	18	1	5.5

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[1] *Medical News,* August 11, 1900.

[2] *Annals of Surgery,* June, 1900.

[3] Quoted by Albarran, *loc. cit.*

[4] *Annales des maladies des organes génito-urinaires,* 1902, No. 11.

[5] *Medical News,* August 29, 1905.

[6] *Annals of Surgery,* December, 1905.

[7] *Beitr. z. klin. Chir.,* p. 423.

[8] *Gaz. hebdom. de Méd. et de Chir.,* 1898.

In nineteen cases of uretero-intestinal anastomosis that recovered, Peterson found that nine succumbed later to some renal affection. One patient with a single ureter implanted in the bowel was alive and well eight years after the operation.

Of the thirty-one patients that survived Maydl's operation, two patients died of pyelitis four and fifteen months respectively after the operation. Of the other cases, the control of the anal sphincter was reported as very good in all except one case. Six fistulas following the operation were noted as having subsequently closed.

CHAPTER XII

OPERATIONS FOR THE REPAIR OF VESICO-VAGINAL FISTULÆ

To promote success in an operation for vesico-vaginal fistula the following points must receive attention:—

1. The urine must, if possible, be rendered aseptic. Urinary antiseptics should be freely administered.

2. Calculi must be searched for and removed from the bladder and cystitis reduced by washing with non-irritating antiseptic solutions.

3. Inflammation of the vagina and vulva must be treated with soothing douches and lotions.

4. Free drainage of the urine should be established for at least a week before the operation and provided for after the operation.

5. At the operation free access to the fistula must be obtained. The vagina is frequently scarred and narrowed in these cases, and a preliminary plastic operation may sometimes be required in order to give access to the fistula. Dilatation by large bougies has been recommended.

6. The ureters must be properly safeguarded by the passage of a catheter or bougie along each duct before beginning the operation.

There are three methods of approach when a vesico-vaginal fistula is to be repaired: (1) Vaginal; (2) Vesical; (3) Intraperitoneal.

Examples of the first method only will be described; the other methods have only been used in exceptional cases, and the reader is referred to the special works dealing with the subject for the details of the operations.

Closure by paring the edges and suture. For this operation the vaginal wall must be supple and the edges of the fistula easily approximated. Small fistulæ low down in the bladder and larger fistulæ high up in the vagina where the tissues are lax are most suitable.

The patient is placed in the dorsal position with the knees and thighs fully flexed and the pelvis raised on a sand-pillow or an Albarran's perineal elevator.

A large vaginal retractor is placed in the posterior wall of the vagina and smaller retractors on each side.

The edge of the fistula is grasped with toothed forceps and pared with a fine-bladed knife or curved sharp-pointed scissors with long handles. If there is a fibrous ring this must be completely removed; but before cutting away any considerable ring of tissue the surgeon should make certain that no tension will be caused when the edges of the wound come to be approximated. Oozing is stopped by pressure with a small swab or by irrigation with hot lotion. Stitches of silkworm-gut or strong catgut are now introduced through the whole thickness of the vaginal and vesical walls without penetrating the vesical mucosa (see Fig. 352). These should be inserted in the direction in which the edges of the wound will most easily come together. Finally a vaginal douche is given and a plug of aseptic gauze placed in the vagina.

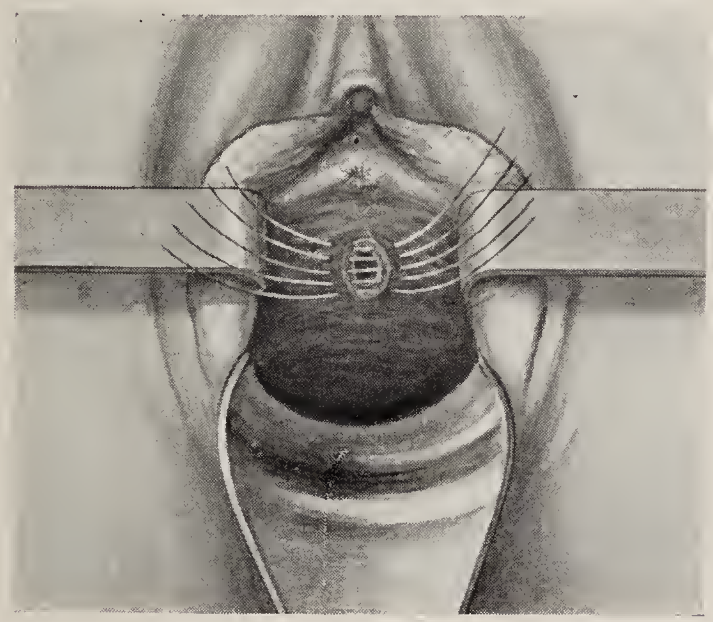

Fig. 352. Operation for Vesico-vaginal Fistula by paring the Edges and Suture.

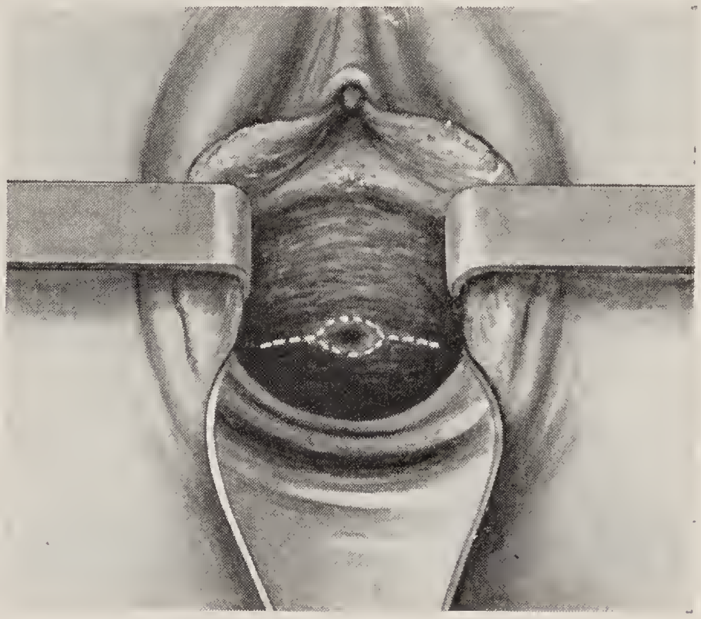

Fig. 353. Albarran's Operation for Vesico-vaginal Fistula. The dotted line traces the incision.

A Pezzer's self-retaining catheter is now placed in the urethra and retained for seven days. After that a catheter is passed at regular intervals for two or three days.

Albarran's operation. The following operation, described by Albarran,[1] is on the lines first practised by Mackenrodt:[2]

An incision is made around the edge of the fistula and this is prolonged on each side (see Fig. 353). By dissection the vesical and vaginal walls are separated for about 1 to 3 centimetres. The two flaps thus formed are seized with forceps and their proper motility assured, if necessary extending the incisions to bring them into apposition. The edge of the vesical portion of the fistula is now pared. The opening

[1] *Loc. cit.*
[2] *Centralbl. f. Gyn.*, No. 8, 1894.

in the bladder is closed by a purse-string suture or by a row of Lembert's sutures. Over this the vaginal flaps are closed by a series of interrupted catgut sutures. The vagina is then washed, and in order to make certain that the wound is firmly closed the bladder is distended with weak antiseptic lotion. If necessary supplementary sutures are introduced. A self-retaining catheter is introduced into the bladder and the outer end prolonged into a urinal. Albarran prefers, when possible, to catheterize the patient every two hours and later increases the interval. This surgeon does not place a tampon in the vagina after the operation, but merely applies a dressing to the vulva. The bladder is washed three or four times a day with a syringe filled with weak antiseptic solution (oxycyanide of mercury 1 in 4,000). In doing this the bladder should not be distended, only a small quantity of fluid being introduced at one time. The bowels are kept confined for four days.

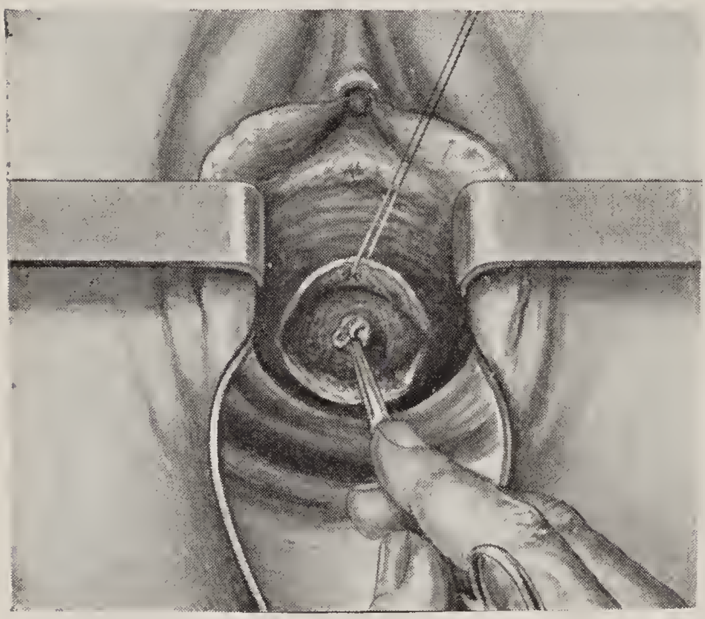

Fig. 354. Braquehaye's Operation for Vesico-vaginal Fistula. Invagination of the fistulous tube. (*Albarran.*)

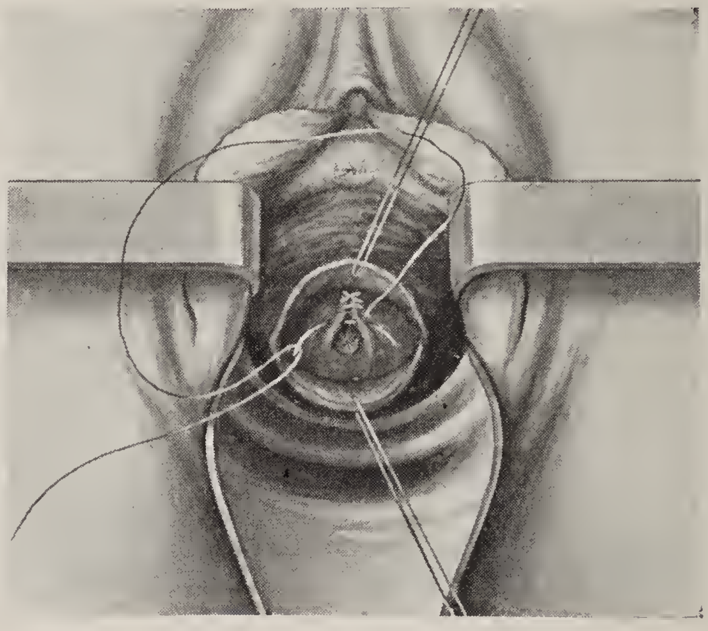

Fig. 355. Albarran's Operation for Vesico-vaginal Fistula. Suture of bladder and vagina.

The operation may be modified in the following points: An elliptical incision is made around the fistula and continued out on each side and a tube of mucous membrane dissected as far as the bladder mucosa. This tube is closed by Lembert's sutures and then invaginated (Braquehaye), or it may be invaginated and a row of Lembert's sutures introduced into the muscular tissues of the bladder and vagina over it (Albarran). The vaginal wall is then closed.

Author's operation. The following method has been practised by the writer where there is severe cystitis with a fistula rather larger than will admit a cedar-wood pencil, bound down by scar tissue at the upper part of the vagina. Adequate drainage of the bladder and some means of traction upon the tissues around the fistula and free dissection of scar tissue are essential points.

Preparation. A week or ten days before the plastic operation the bladder is opened above the pubes. If calculi are present these are removed and the bladder is washed with a copious stream of antiseptic solution (biniodide of mercury 1 in 10,000, or oxycyanide of mercury 1 in 5,000). A large drainage tube, about ¾ inch in diameter and with one or two eyes near the vesical end, is introduced, and the bladder washing repeated daily, or twice a day if necessary.

During the week preceding the plastic operation, the vagina is washed daily with solutions similar to those used for the bladder, and a frequently changed tampon smeared with boracic ointment introduced into the vagina to prevent the constant soaking with urine. The operation is immediately preceded by a thorough cleansing of the vagina and bladder.

Operation. The patient is placed in the dorsal position with the thighs and knees fully flexed and the pelvis raised by means of a sand-pillow. A catheter is introduced into each ureter either through a speculum in the suprapubic wound or through the urethra by means of a Kelly's tube. A prostatic retractor—I prefer that of Young—is now introduced from the vagina through the fistula into the bladder. Traction is made by pulling upon this tractor, which is held in the left hand of the surgeon.

With a fine sharp-pointed long-handled knife an incision is made through the vaginal mucous membrane about ⅛ inch from the margin, and this is deepened around the shank of the retractor (see Fig. 356). On each side of the fistula an incision is carried outwards transversely for an inch or more, and at the end of each incision a longitudinal incision is made 1½ inches in length, the middle of which meets the end of the transverse one. The retractor is handed to an assistant and the edge of the flaps thus marked out is picked up in long-toothed forceps, and the flap dissected by means of a long-handled angled knife assisted by sharp-pointed curved scissors (see Fig. 357). The whole thickness of the vaginal wall is raised in each flap. The ureters are defined by touch and are carefully avoided. The incision round the fistula is deepened to the bladder mucous membrane and a small ring of tissue which formed the wall of the fistula is thus isolated around the shank of the retractor. With a fully curved Hagedorn's needle of small size held in a long holder a Lembert's suture of catgut is placed in the muscular wall of the bladder immediately in front of, and another behind, the fistula (see Fig. 358). The blades of the retractor are now closed and

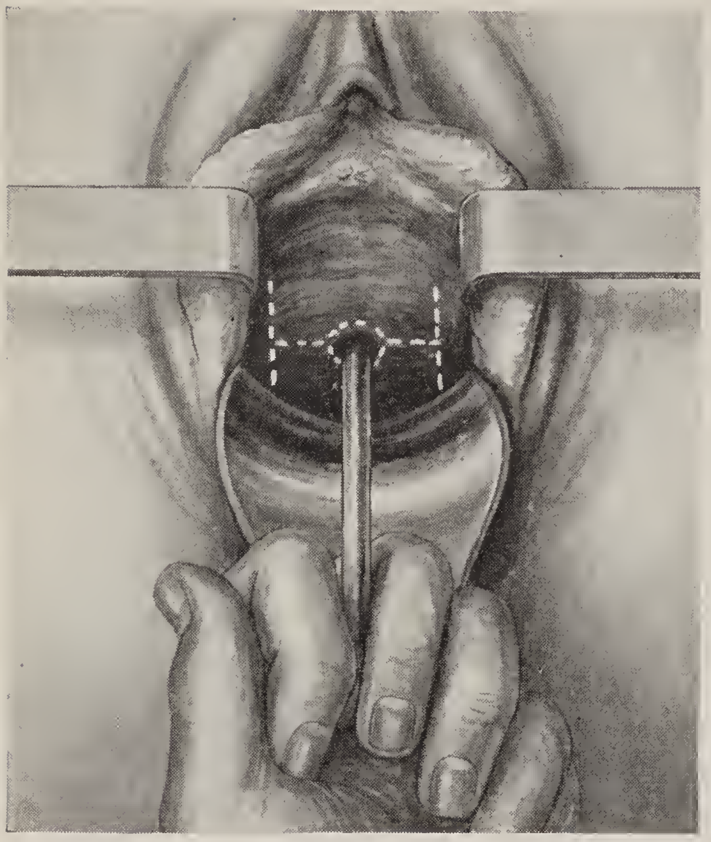

FIG. 356. AUTHOR'S OPERATION FOR VESICO-VAGINAL FISTULA. *First stage.* The dotted lines trace the incision in vaginal wall. The retractor has been introduced through the fistula and drags down and steadies the surrounding tissues.

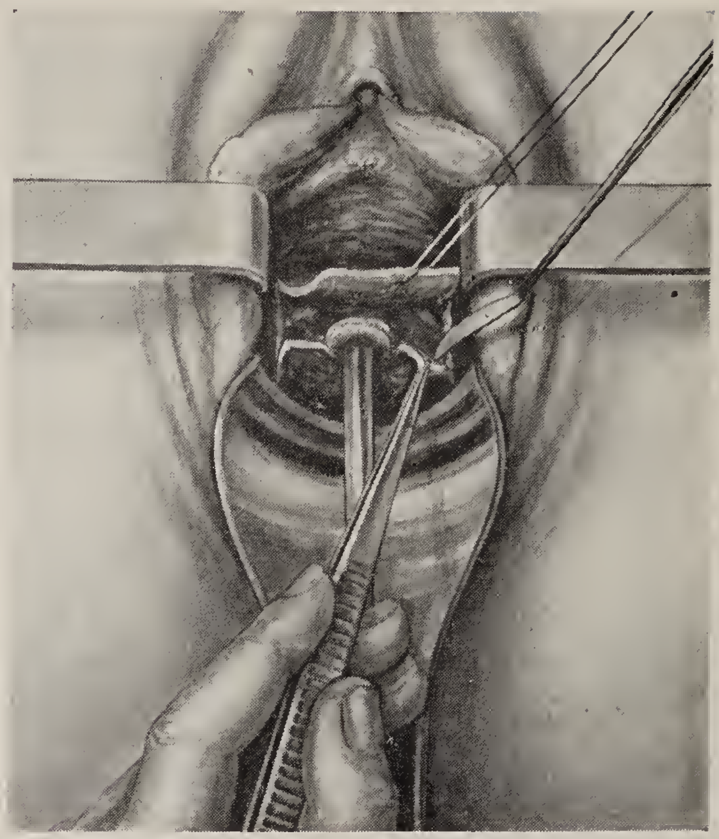

FIG. 357. AUTHOR'S OPERATION FOR VESICO-VAGINAL FISTULA. *Second stage.* The fistulous track has been dissected up and the anterior flap raised. The posterior flap is being dissected up. The position of the ureters is shown at the anterior corners of the denuded area.

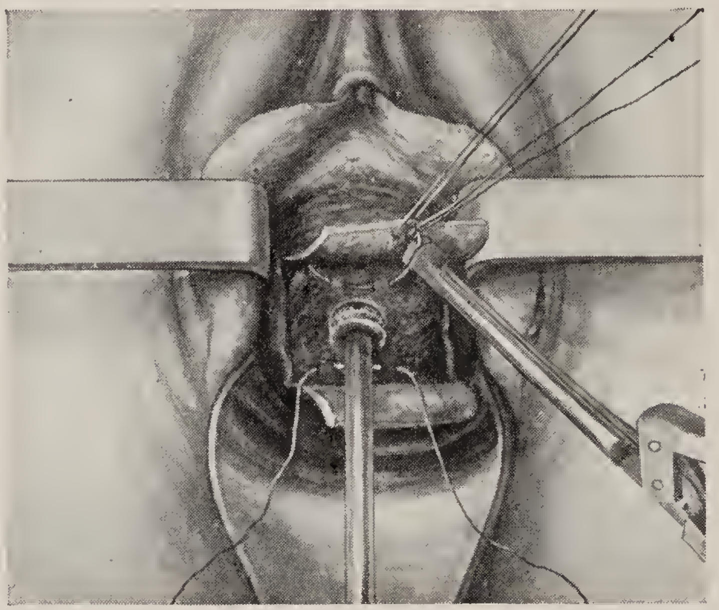

FIG. 358. AUTHOR'S OPERATION FOR VESICO-VAGINAL FISTULA. *Third stage.* The fistulous track has been dissected free around the shank of the retractor and the flaps raised. Lembert's sutures are being introduced in front of and behind the fistula.

the instrument withdrawn, carrying with it the ring of tissue which formed the wall of the fistula.

Aided by traction upon the sutures a closely set row of interrupted catgut sutures is introduced from before backwards after the Lembert method in the muscle of the bladder-wall (see Fig. 359). The upper and lower vaginal flaps are now united by interrupted catgut sutures (see Fig. 360). The vagina is washed out and a soft roll of aseptic gauze placed in the vagina so as to keep the vaginal and vesical walls in contact at the site of the operation. The vaginal retractors are removed and the legs extended. The bladder is washed out through the suprapubic wound and the large rubber drainage tube reintroduced.

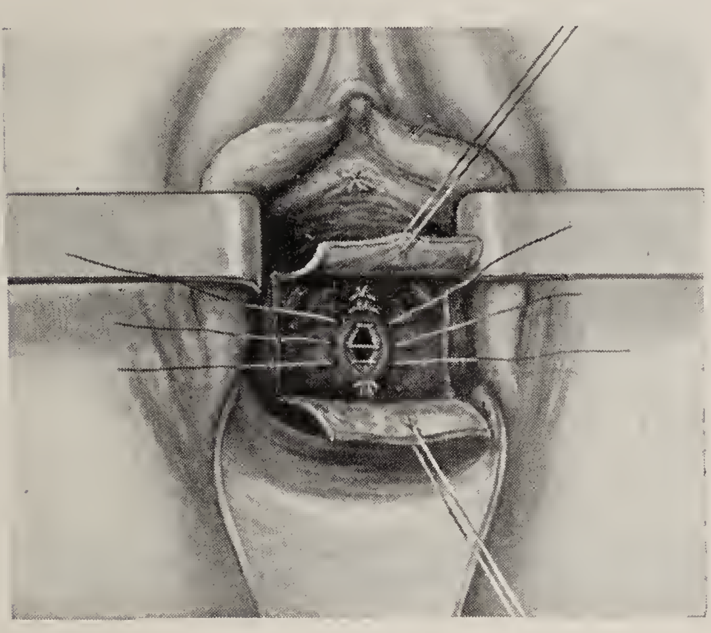

Fig. 359. Author's Operation for Vesico-vaginal Fistula. *Fourth stage.* Closure of the fistula by Lembert's sutures.

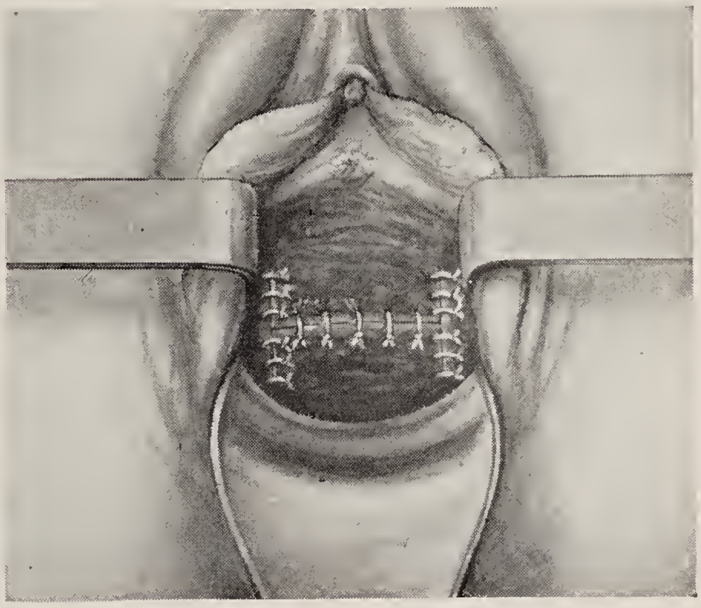

Fig. 360. Author's Operation for Vesico-vaginal Fistula. *Fifth stage.* The vaginal wound closed.

After-treatment. A White's suction apparatus is fitted (see p. 633) and the bladder kept dry. The bladder and vagina are flushed out daily in the same way as before the operation. The tube and suction apparatus are removed at the end of five days and the suprapubic wound allowed to heal.

SECTION VI

OPERATIONS UPON THE GENITO-URINARY ORGANS

PART III

OPERATIONS FOR VESICAL CALCULUS

BY

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CHAPTER XIII

LITHOLAPAXY

CHOICE OF OPERATION

Litholapaxy is the operation of choice in patients of all ages and both sexes. So far as mortality goes, there is little to choose between lateral lithotomy and litholapaxy in males below the age of puberty; but the period of convalescence after the latter may be reckoned in days, instead of weeks in the former. Even in the most experienced hands there will remain a certain proportion of cases in which litholapaxy will be inapplicable and in which a cutting operation must be had recourse to. These may be summarized thus:—

1. Huge calculi, *viz.* of about 2 ounces in weight and upwards, are best treated by suprapubic lithotomy, though soft phosphatic stones of much larger dimensions can be successfully dealt with by litholapaxy.

2. Suprapubic lithotomy is almost invariably indicated for encysted calculus.

3. A calculus partially impacted in the prostatic urethra and which cannot be displaced into the bladder, to be crushed there, is best treated by median lithotomy.

4. Where, though the stone is not very large, the bladder is rigid, contracted, and irritable, resenting the presence of the fluid that is necessary for the safe performance of litholapaxy, lateral or median lithotomy should be employed according to the estimated size of the stone.

5. When tumour of the bladder coexists with stone, suprapubic lithotomy is indicated, so that the tumour can also be removed at the same time.

6. When tight fibrous stricture of the urethra coexists, median lithotomy is indicated, the stricture being cut at the same time, unless the stone is so large as to necessitate suprapubic lithotomy.

7. When enlargement of the prostate coexists with stone, the prostate and stone should be removed by the suprapubic route.

In these remarks regarding the choice of operation I have assumed that the surgeon is one with considerable experience in this branch of surgery. A very pertinent and practical question, however, is this—Assuming the stone be an uncomplicated one of moderate size, what is the operation that is likely to give the most favourable results in the hands of the general surgeon who only occasionally encounters a case of vesical calculus? Unhesitatingly I say a cutting operation of some kind. The fashion in England has in later years turned in favour of the suprapubic route: in India lateral lithotomy still holds the field. I am not aware that any hospital statistics have in recent years been published in England to guide us in our choice between those two operations. But if any conclusions may be drawn from general inquiries that I have made, I have a strong suspicion that statistics collected from a large number of London and provincial hospitals would be in favour of lateral lithotomy.

INSTRUMENTS

The crushing of the stone is accomplished by means of *lithotrites*, similar to those employed for the old operation of lithotrity, except that, owing to the increased scope of the new operation in dealing with hard and large calculi, some of the lithotrites employed for adults are constructed much larger and stronger than those formerly in use. On the other hand, owing to the more recent extension of the modern operation to male children of the most tender ages, extremely small and slender lithotrites are now employed. In Fig. 361 is illustrated a lithotrite constructed on the well-known model of Weiss and Thompson. It possesses the cylindrical handle introduced by Sir Henry Thompson, which (in the words of the inventor) 'enables you, in the search for a small stone or fragments, to execute rapid and delicate movements which would be impossible in an instrument without the cylindrical handle.' It also possesses the new mode of changing sliding into screwing action, and *vice versa*, introduced by Weiss. When the small button in front of the cylinder is pushed back into the position indicated in the illustration, the instrument is 'locked,' and then the male blade moves within the female blade by a screwing action only; but when the button is pushed forwards in the direction of the blades, the instrument is 'unlocked,' and the screwing is converted into a sliding action. The male blade, which is deeply serrated or toothed, passes through the female blade, driving the débris through the opening in the latter, or tossing it away on either side, so that no blocking of the blades by fragments can occur.

In Bigelow's lithotrite (see Fig. 362) the cylindrical handle of Thompson's instrument is retained for the left hand; but instead of the wheel for the right hand a ball is substituted. This is an undoubted improvement, affording a much firmer grip, a point of great importance when dealing with a large and hard calculus. But the special feature of Bigelow's lithotrite is the introduction of a new mode of locking the instrument. This is effected simply by a quarter rotation of the right wrist, whilst the hands are in position, without any displacement of the fingers; whilst a quarter rotation of the wrist in the opposite direction unlocks the instrument. In the lithotrites of Weiss and Thompson, the thumb of either hand has to be disengaged to move the button, a performance which tends to render the lithotrite in the bladder unsteady at the critical moment of catching the stone. By the ingenious device of Bigelow this objection is obviated—a decided improvement.

I cannot say, however, that I like the blades of this instrument nearly as well as those of the fenestrated lithotrites by Weiss and Thompson already described. ‘The blades of this lithotrite consist of a shoe, or female blade, the sides of which are so low that a fragment falls upon it; while the male blade, or stamp, offers a series of alternate triangular notches, by whose inclined planes the detritus escapes laterally after being crushed against the floor and rim of the shoe. At the heel of the shoe, where most of the stone is usually comminuted and where the impact is therefore greatest, the floor is high and discharges itself laterally, while its customary slot is made to work effectually’ (Bigelow). The blades are essentially non-fenestrated and liable to get clogged with débris, as I have frequently found in practice, and therefore objectionable.

In 1886 I had constructed for me by Weiss a lithotrite (see Fig. 363), in which the handle and locking action of Bigelow are combined with the fenestrated blades of Weiss and Thompson. Th

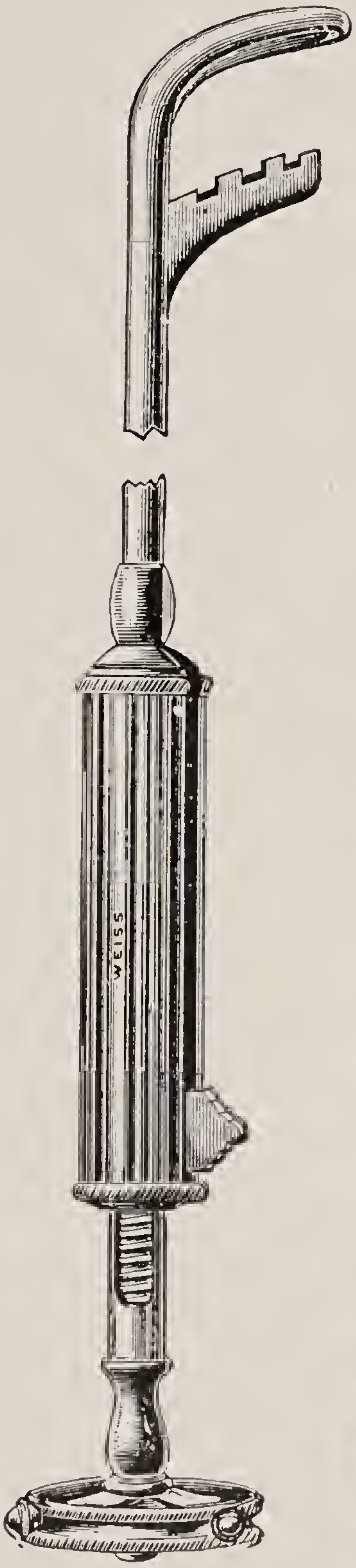

Fig. 361.
Lithotrite (*Weiss and Thompson pattern.*)

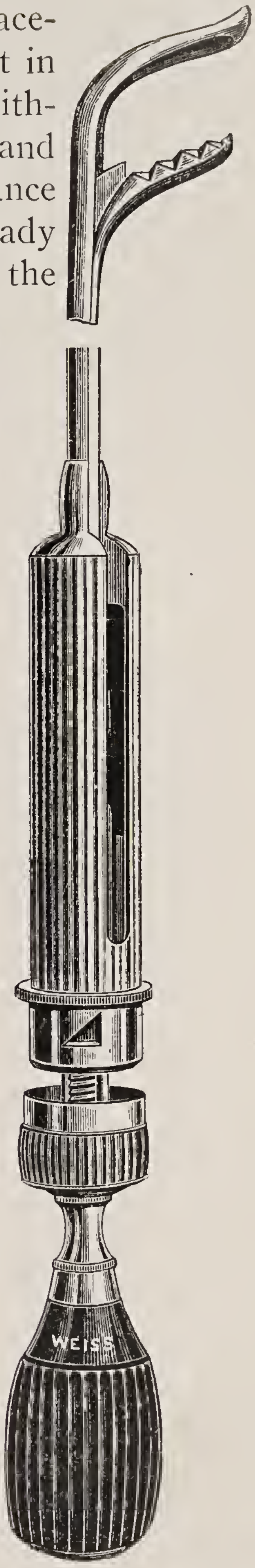

Fig. 362.
Bigelow's Lithotrite.

female blade is completely fenestrated, the male blade passing right through, so that when closed their under surfaces are flush with each other, and thus all fear of impaction of fragments is avoided. The upper edges of the female blade are smooth, and bevelled on their inner aspect, so that there is much less chance, in unpractised hands, of the mucous membrane of the bladder getting nipped between the blades than in those lithotrites in which the upper edges of the female blade are toothed. Over twenty years' acquaintance with this lithotrite enables me to say that it is practically perfect in its working, and it is the model on which my lithotrites have since been constructed.

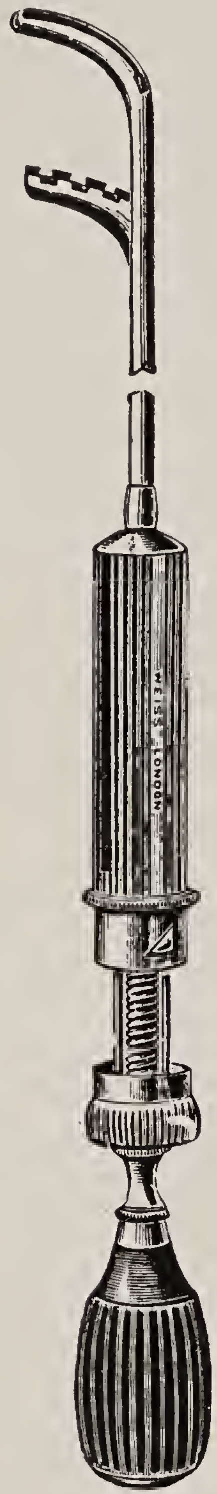

Fig. 363.
Freyer's Lithotrite.

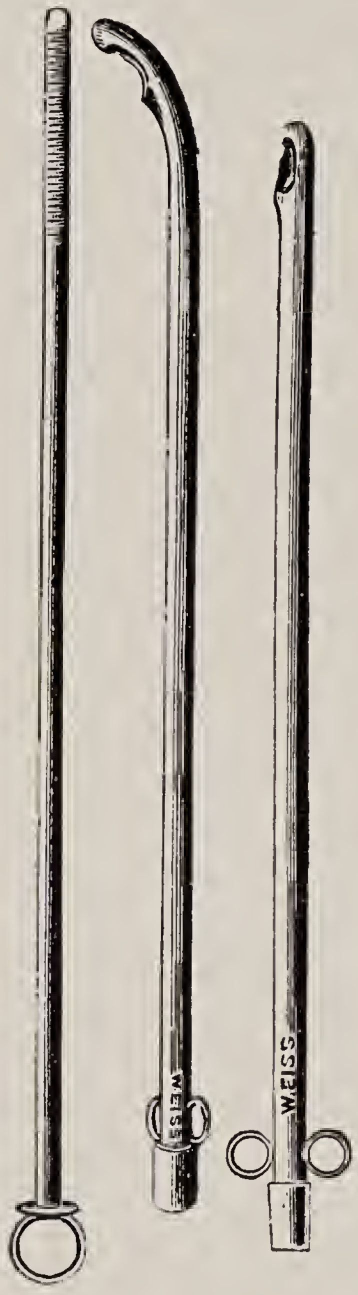

Fig. 364.
Canulæ and Stylet.

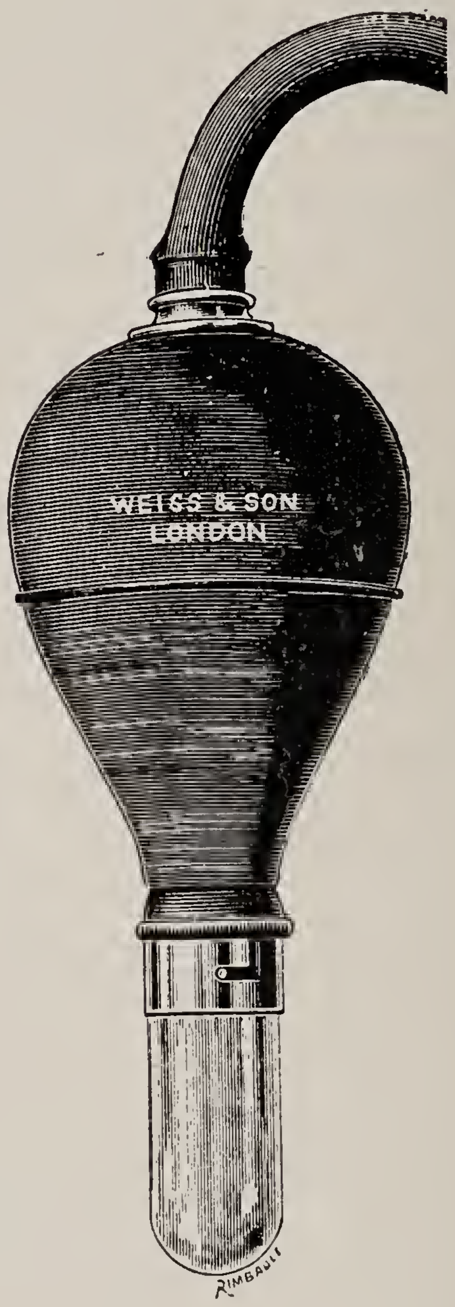

Fig. 365.
Bigelow's Original Aspirator.

The second object aimed at in the operation, the removal of the débris from the bladder, is accomplished by means of large cylindrical tubes, or *evacuating catheters,* introduced through the urethra, and an aspirator, or suction apparatus, attached thereto.

The canulæ employed vary in size according to the capacity of the urethra, Nos. 6 to 11, English scale, being used for male children, and Nos. 12 to 18 for adults and females of all ages. In my own practice I have not found it necessary to use a larger canula than No. 18, and through a tube of this calibre I have removed the débris of a calculus weighing 6¾ ounces. I have, however, met with cases in which a No. 19 or 20 canula might have been passed with facility. Canulæ (see Fig. 364) are made of thin silver, and vary in shape, some being straight, and some slightly curved at the extremity. The latter I prefer as I find them more easy to introduce. The orifice, or eye, should be large enough to admit any fragment that will pass through the tube. The canulæ should be armed with stylets (see Fig. 364) for reasons that will appear later on.

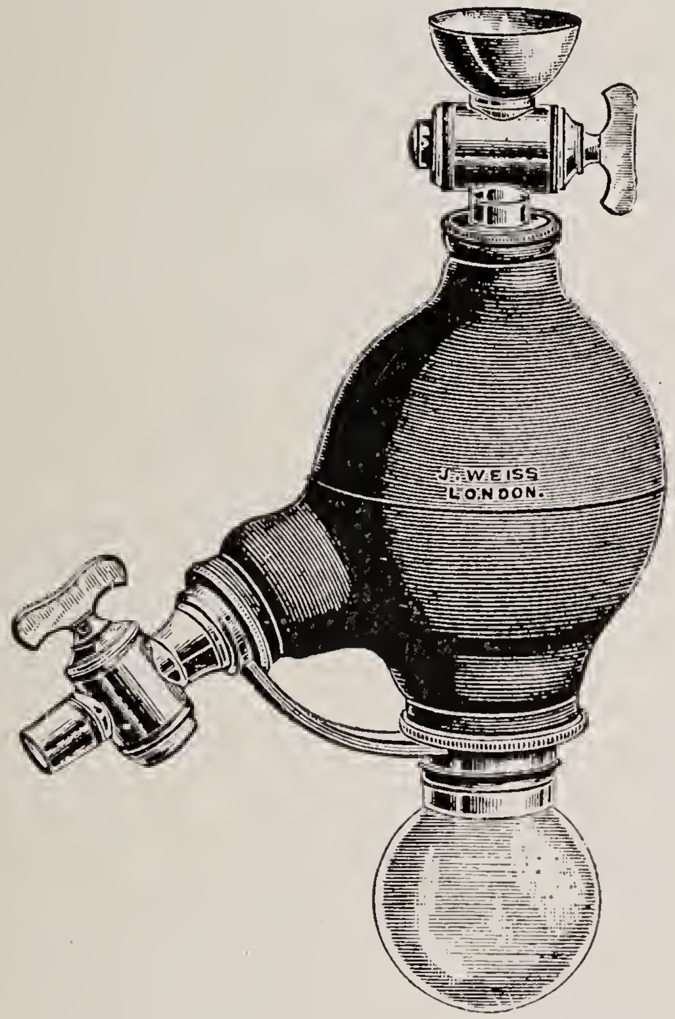

Fig. 366. Bigelow's Improved Aspirator.

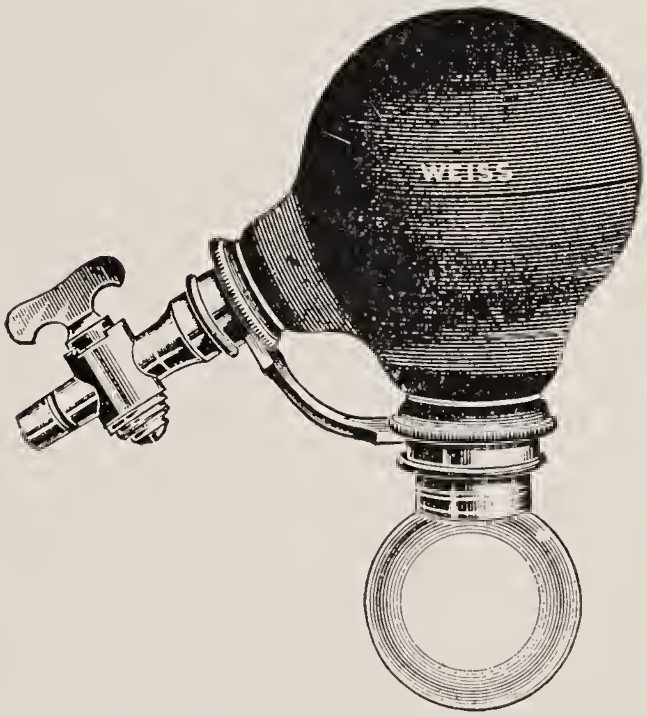

Fig. 367. Freyer's Aspirator.

The original *aspirator* of Bigelow is represented in Fig. 365. It consisted of an elastic bulb or central portion, to the lower extremity of which was attached a removable cylindrical glass receiver; whilst from its upper part passed an india-rubber tube, the end of which fitted on to the evacuating catheter previously introduced into the bladder. By alternate expansion and compression of the bulb, the water was pumped into, and withdrawn from, the bladder, and the débris which was carried back into the aspirator fell down into the glass receiver, and was there retained.

This aspirator was gradually modified and improved by Bigelow himself and others. The modification of Bigelow's aspirator represented in Fig. 366, with which I worked for several years, I found very efficient. In 1895 I had this latter aspirator simplified still further (see Fig. 367) by dispensing with the tap above the rubber bulb, which was not really necessary, as the apparatus can be easily filled through the front tap, to which the canula fits. This may be effected still more rapidly by removing the glass receiver from the bulb, immersing both in a basin full of fluid, and then attaching the glass receiver to the bulb whilst the whole apparatus is immersed in the fluid. In this way all air is excluded. I have employed this aspirator exclusively for many years. It is very light and handy and thoroughly efficient in all respects.

IN ADULT MALES

Operation. It will be well to submit the patient to preliminary treatment for a few days previous to undertaking the operation. The patient should be put to bed and placed on a light nourishing diet. The bowels should be regulated, a purgative being given should constipation exist, and mild astringents should the patient suffer from diarrhœa, which is often the case.

For the operation I find a low, narrow operating table the most convenient. The patient is placed on this, close to the right edge, with his head resting on a pillow. The buttocks are raised by means of a low cushion placed beneath them. This is an important point, as the stone thus gravitates to the base of the bladder, away from the neck, and renders the latter part, which is the most sensitive, less likely to be injured in the various manipulations. The legs and thighs are flexed and slightly abducted.

It is very essential that the patient should be protected by warm clothing during the operation to prevent chill. For this purpose a pair of large woollen stockings should be slipped on, reaching up the thighs close to the groins.

Close to the operator's right hand should be placed a small table, with a tray or basin containing warm carbolic lotion, in which the lithotrites and evacuating catheters should be placed ready for use; while the aspirator, previously filled with warm boric lotion, should be entrusted to an assistant conversant with its working. It is well, when possible, to have two or three aspirators ready at hand, to be used alternately. The operation is thus facilitated, as while the surgeon is using one, a second can be emptied of débris and refilled with water by the assistant.

Before undertaking the operation of litholapaxy the surgeon must learn to pass all instruments—lithotrites, sounds, and catheters—on the right side. This requires only a little practice to do it with ease, and much time is saved thereby. Besides the loss of time involved, it is extremely awkward to see a surgeon passing the instruments on the patient's left side, and then going round to the right side to use them.

The patient now being, as a rule, anæsthetized, the surgeon, standing on his right side, should first pass a large conical steel sound into the bladder. A series of highly-polished sounds of this kind (see Fig. 368), from No. 6 to 18, should be at hand. They should be made slightly tapering to the point, so that the diameter there is two sizes smaller than higher up at the bend. Solid heavy sounds of this kind are easily passed, and are handy for ascertaining the capacity of the urethra, and for facilitating the passage of other instruments. It will frequently be found that, when neither a catheter nor a lithotrite will pass into the bladder, a heavy sound of this shape will do so; and on its withdrawal the lithotrite or canula may be slipped in. The meatus is, as a rule, the narrowest part of the urethra, and it will occasionally be found necessary, in order to pass the large instruments employed in litholapaxy, to enlarge it slightly. Should, therefore, a large sound not pass, this must be done at once. For this purpose a director is introduced into the urethra, and the floor of the meatus is incised by means of a long slender scalpel.

The question now arises as to the quantity of water the bladder should contain during the crushing of the stone. As a rule, a very small quantity, from 2 to 4 ounces, will be sufficient to protect the walls of the bladder, and at the same time permit of the necessary movements of the lithotrite. A large quantity of water is objectionable, involving an increased area over which the fragments, impelled by the currents set up by the movements of the lithotrite, may roam, thus increasing the difficulty in catching them. If, on the other hand, the bladder be completely empty, injury to its walls may result from the lithotrite.

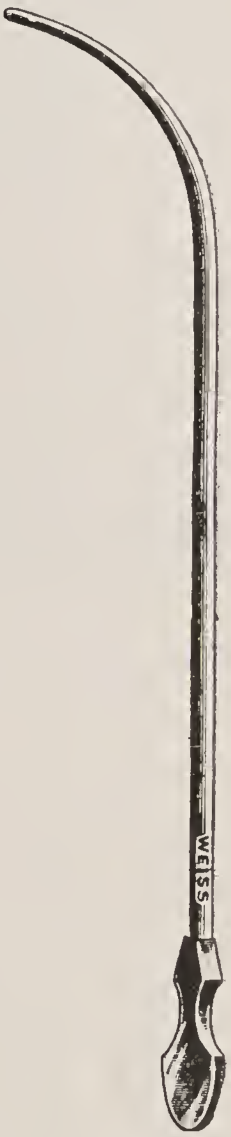

Fig. 368.
Graduated Steel Sound.

The lithotrite is now introduced thus: The operator stands obliquely with his left side towards the patient's face. The lithotrite, previously screwed home, locked and lubricated, is held horizontally in the right hand by the cylindrical handle, with the beak pointing downwards. The penis is grasped between the thumb and the two first fingers of the left hand, and the beak of the instrument is introduced into the urethra (see Fig. 369), the penis being drawn slowly but steadily on to the lithotrite, which is gradually elevated till it reaches the perpendicular position (see Fig. 370), as it slides along the canal, which it does by its own weight. The beak will now have entered the membranous portion of the urethra as it passes through the triangular ligament. By gently depressing the handle of the lithotrite in the middle line towards the horizontal position, the beak will be found to slip along the membranous and prostatic portions of the urethra and into the bladder.

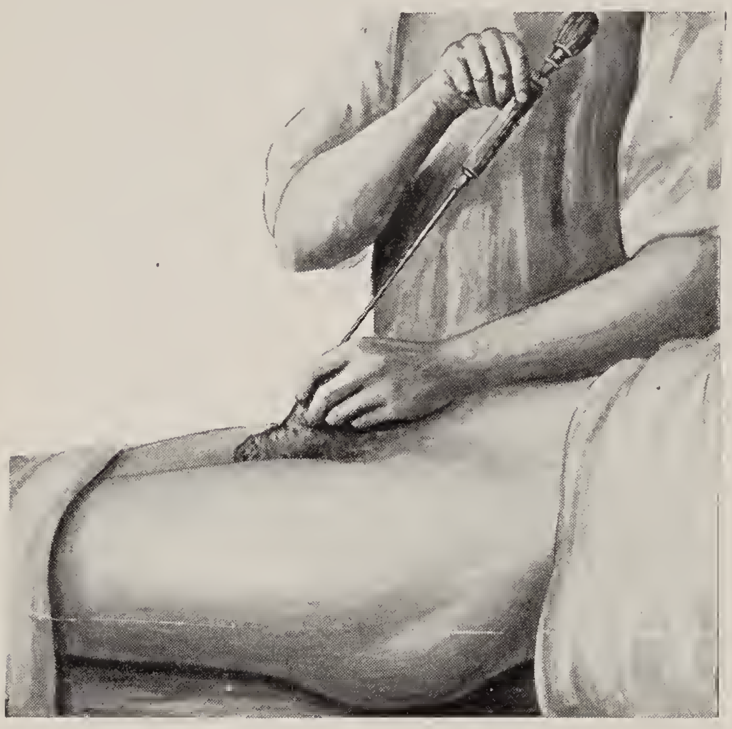

Fig. 369. Introduction of the Lithotrite. *First position.*

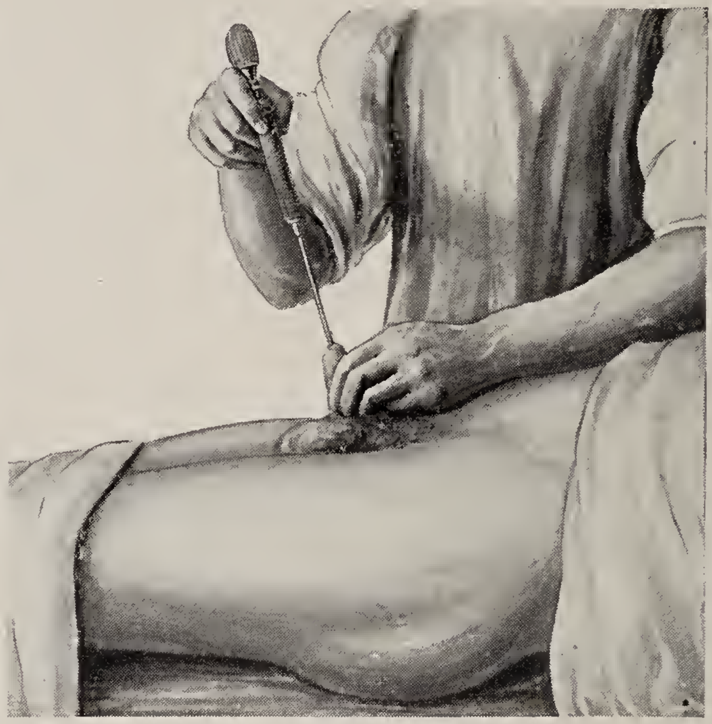

Fig. 370. Introduction of the Lithotrite. *Second position.*

The lithotrite being thus introduced, the next stage of the proceedings consists in *catching the stone.* For this purpose the lithotrite is passed gently onwards, or, rather, allowed to proceed by its own weight, along the trigone, till it reaches the most dependent part of the base of the bladder, on which it is allowed to rest. The instrument is then unlocked, and the blades opened by withdrawing the male blade an inch or more, according to the size of the stone, the female blade being held steadily in position by the left hand on the cylindrical handle. The blades are now closed, when, frequently, the stone will be found between them (see Fig. 371). The lithotrite is locked, and lifted slightly off the base of the bladder, and the stone is crushed by screwing the male blade home (see Fig. 372). The instrument is again unlocked, the blades opened and closed, when a fragment will be caught and crushed as before. This process is to be repeated several times, till a considerable quantity of fine débris is made. Sir Henry Thompson compares the finding of fragments to fishing for perch—where one is found there will many be caught. We must not go searching about the bladder for fragments till those in the locality in which the stone is first found are disposed of. The depression in the base of the bladder, caused by the weight of the lithotrite resting on it, facilitates the stone, and subsequently its fragments, falling on to the female blade.

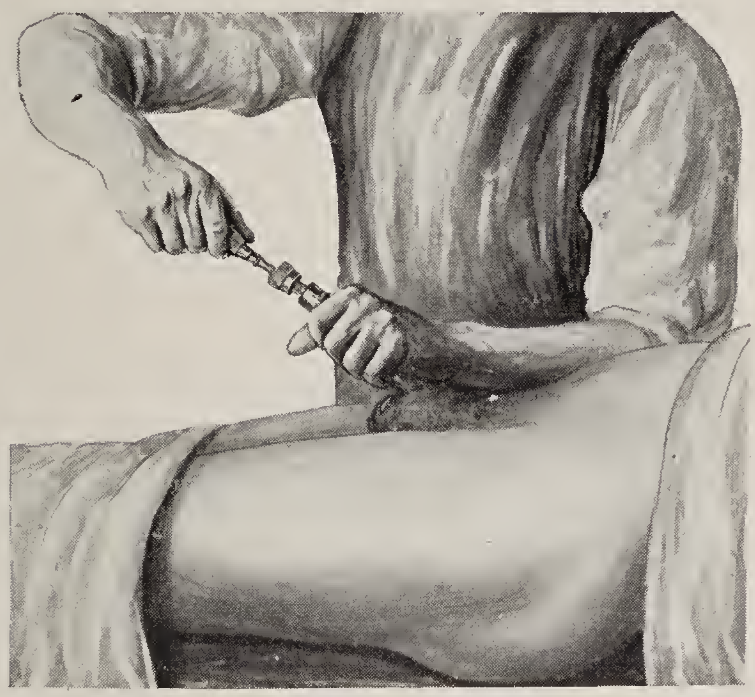

Fig. 371. Litholapaxy. *Searching for the calculus.*

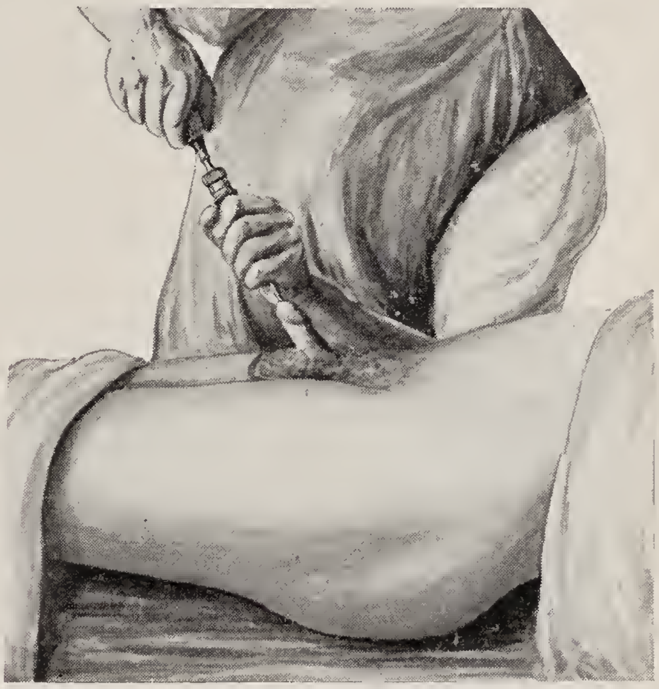

Fig. 372. Litholapaxy. *Crushing the calculus.*

Should the stone not be found by the manœuvre above indicated, it must be searched for. This is done by opening the blades of the lithotrite, turning them at an angle of 45° towards the right, and again towards the left, and closing them in these positions respectively. Should the stone still evade detection, the handle of the lithotrite must be depressed towards the horizontal position between the thighs, pushed an inch or so towards the posterior surface, and the same manœuvres gone through in that position, searching centrally, right, and left. The stone will probably be found in one of these positions; but sometimes it lies immediately behind the prostate, especially when that gland is enlarged. To grasp the stone in this position the handle of the lithotrite should be depressed between the thighs, and turned right round on its axis, so that the beak points towards the trigone, but should not touch it. The blades are then opened and closed as before in this position, and if the stone lies there it will be secured. In fact, the surgeon should make a mental survey of the whole bladder, and institute a methodical search of every part of it till the calculus is found. All the movements must be light and graceful, and care taken that the mucous membrane is neither caught between the blades nor otherwise injured. In whatever position found, the stone must be brought to the centre of the bladder and there disposed of.

Let us now assume that the stone, or a portion of it if a large one, has been reduced to fine débris. Should the stone be a small one—say, from a few grains up to 3 or 4 drachms in weight—its complete pulverization will probably be accomplished before the lithotrite is withdrawn, in a period varying from one to eight or ten minutes. But should the stone be a large one, a considerable amount of crushing, lasting over ten minutes or so, must be effected before removing the instrument. Before withdrawing the lithotrite, it must be locked and the blades screwed tightly home, so as to render them free of débris. I may here say that no instrument should be withdrawn from the bladder till quite free of fragments.

The evacuating catheter, armed with a stylet, should now be passed into the bladder, the largest size that the capacity of the urethra will easily admit being used. As soon as the stylet is withdrawn, a rush of water and débris will take place, to receive which a porringer should be at hand. The experience already gained in passing the solid sounds and lithotrites will afford a rough estimate of the size of the canula that the urethra will admit.

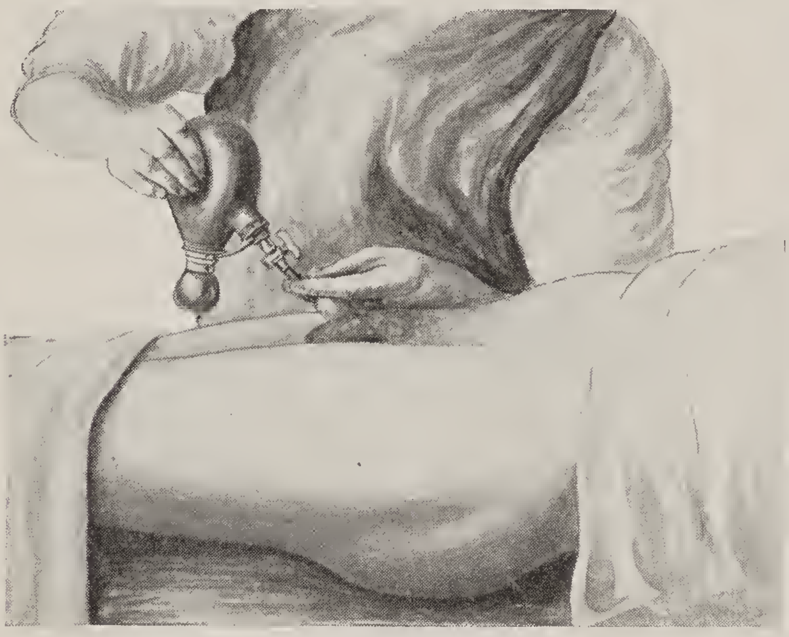

Fig. 373. Litholapaxy. *Aspiration of débris.*

The canula having been introduced into the bladder, the aspirator, previously filled with warm boric lotion, is applied, the tap turned on, and the aspiration of the débris begun. The right hand grasps the bulb of the aspirator, by the compression and expansion of which water is injected into, and withdrawn from, the bladder (see Fig. 373). With the outward stream the fragments are carried, and are seen to fall into the glass receiver, where they remain. Should the stone be a small one, and have been completely crushed at the first introduction of the lithotrite, it will be found that, after the aspiration has gone on for a time, the whole of the débris will have passed into the receiver. But if the stone be a large one, after a considerable quantity of débris has entered the receiver, which will vary with the amount of crushing at the first introduction of the lithotrite, little or no débris returns with the outward stream, but a rattling sound takes place, due to the fragments too large to pass out being carried with force against the eye of the canula.

The aspirator is then removed, the canula, rearmed with the stylet, is withdrawn, and the lithotrite again introduced for the purpose of crushing more fragments. This is followed by the canula and aspirator as before. This process may have to be repeated many times, according to the size of the stone, before the whole of the débris is removed.

In the healthy urethra of an adult there are only two situations, as a rule, where difficulty may be encountered in the passage of instruments, viz. at the triangular ligament, and at the neck of the bladder. The instrument (lithotrite or canula) should first be passed as far as it will go in the direction of the anus, thus depressing the floor of the urethra in front of the triangular ligament. 'Traction on the penis next effaces this depression, and adds firmness to the urethral walls; so that, if the instrument be withdrawn a little, and at the same time guided by the bony arch above, it can be coaxed without difficulty through the ligament in question—a natural obstruction which physicians often mistake for a stricture. The obstruction passed, the rest of the canal is short, and corresponds with the axis of the body' (Bigelow).

The obstruction sometimes met with at the neck of the bladder is due to the firm lower edge of the inner meatus. This may be overcome by pushing the lithotrite or canula gently onwards in the direction of the axis of the body, imparting to it a slightly rotatory motion if necessary.

When the urethra is capacious, and large evacuating catheters can be passed, as in the great majority of cases in the adult, it is unnecessary to reduce the stone to fine sand, as coarse débris can pass through these tubes into the aspirator, and it is waste of time to reduce the débris to a finer consistence than what will pass through the canula with facility.

During the earlier part of the process of aspiration, the end of the canula should be kept towards the centre of the bladder, raised from the base, and may be moved about slightly in various directions to facilitate the flow of the fragments towards the eye; but towards the completion of the process the canula should be allowed to rest on the base, so as to gather up the sand and last fragments.

Towards the completion of the operation it will be found that, as a rule, the last particles of débris lie close to the neck of the bladder, just behind the prostate. This is due to the fact that the eye of the canula being turned towards the posterior aspect and sides of the bladder, the water is less disturbed by currents in the position referred to than in any other. Consequently, the last particles of débris gravitate towards this spot. Towards the end of the operation, therefore, the eye of the canula should always be turned right round towards the prostate, and water forcibly injected, so as to dislodge the débris from this position. This manœuvre is especially necessary where enlargement of the prostate coexists, otherwise a fragment might be left behind.

On compressing the bulb and pumping water into the bladder, the débris is scattered away from the eye of the canula. Before allowing the stream to return by the expansion of the bulb the hand should rest a second or two, so as to allow the débris to settle down again in the vicinity of the eye. The evacuation of the débris will sometimes be found to take place best by injecting 2 or 3 ounces of water into the bladder with each compression of the bulb; at others a much smaller quantity will be found more effectual. No definite rule can be laid down for all cases.

It sometimes happens, even when the patient is fully anæsthetized, that spasm of the bladder occurs. During its existence all manipulation should be suspended, otherwise the bladder might be injured. Should the lithotrite be in the bladder, it must be closed and kept unmoved till the spasm passes over. If the canula be in the bladder, the water should be allowed to escape.

During the process of aspiration, with each expansion of the india-rubber bulb the fragments of calculi are carried against the eye of the canula by the outward rush of water, and a clicking sound is thus produced, which, whilst it continues, indicates that some fragments remain in the bladder. There is, however, a peculiar sound sometimes produced, the occurrence of which the young litholapaxist should be acquainted with, as it is very likely to be confounded with the sound produced by a fragment. This ‘ false sound,’ as it may be called, is produced by the mucous membrane of the bladder being sucked into the eye of the canula during the exhaustion of the water. It is most likely to occur towards the end of the operation, when all, or nearly all the fragments have been exhausted, and especially when the bladder contains no surplus water, only that quantity which is pumped in and withdrawn during compression and expansion respectively of the bulb. It may, however, be produced at any time if, after compressing the bulb, the eye of the canula be turned towards the sides, or directed up against the apex of the bladder, and the bulb of the aspirator be then allowed to expand. The sound itself, though difficult to describe, can never be mistaken when once recognized. The sensation communicated to the hand is of a fluttering, jerky character, accompanied by a dull, muffled sound as contrasted with the clear ringing click which the impact of fragments imparts to the instrument. On its occurrence the outward stream receives a sudden and complete check; whereas when a fragment obstructs the stream, a portion of the water continues to flow. The sound does not recur if the canula be partially withdrawn and raised towards the perpendicular position so as to bring the eye close to the neck of the bladder, with the end of the canula resting on the trigone; whereas a fragment will produce obstruction there as well as in any other position. On first practising litholapaxy I was deceived by this sound, and since then I have seen many inexperienced litholapaxists similarly deceived.

It frequently happens that, during the process of aspiration, a fragment which is too large to pass through the canula gets caught in its eye. This is recognized by the fact that the outward stream is arrested, and the bulb of the aspirator ceases to expand. The fragment should at at once be displaced. This, as a rule, may be effected by compressing the bulb suddenly and with force, when the fragment will, as a rule, be expelled by the inward stream. Should this manœuvre fail after being tried two or three times, a stylet should be introduced through the canula, and the fragment displaced in this way. But the canula should on no account be withdrawn with the fragment sticking in its eye, as in this way the urethra may be injured, or the fragment get caught in the mucous membrane, displaced from the eye of the canula, and thus impacted in the urethra.

Should a fragment get impacted in the urethra, how are we to deal with it? If the precautions indicated in the last paragraph are taken, there will be little fear of its occurrence. Still, it is an accident that has to be reckoned on. If the fragment be lodged in the prostatic portion of the urethra, it may easily be displaced backwards into the bladder by passing a large canula as far as the obstruction, applying the aspirator, and injecting water with some force, when, as a rule, the fragment will rush back into the bladder, to be there disposed of. If the fragment be arrested in the anterior 3 or 4 inches of the canal, it can be removed with one or other of the various kinds of urethral forceps in use (see Fig. 374). When deeply placed in the membranous portion of the canal, it may still be removed in this manner; but, if tightly impacted, it may be necessary to remove it by external urethrotomy, an occurrence which, however, I have never seen.

Where there is great irregularity of the inner surface of the bladder, it may be extremely difficult to get rid of the last fragment. I have experienced this frequently. The aspirator is applied, and time after time the fragment clicks against the eye of the canula, but, on introduction of the lithotrite, the fragment cannot be grasped. Great perseverance may be necessary, especially if the fragment be a broad thin shell from the outer crust of a large stone. A manœuvre that I have found useful is to employ the suction force of the canula and aspirator to bring the fragment out of the depression in which it lies, close to the neck of the bladder, and then to introduce the lithotrite and catch the fragment in this position. If the fragment lies in a depression behind the prostate, the forefinger may be introduced into the rectum. The lithotrite being in the bladder, the fragment of stone may now be pushed out of the depression in which it lies by the point of the finger, and caught by the lithotrite with a little manipulation.

As a rule, there ought to be little or no loss of blood attending the operation, with the exception of the trifling bleeding that follows the incision in the floor of the urethra, when this is necessary to enlarge the meatus. I have frequently removed very large calculi with scarcely a tinge of blood in the washings from beginning to end. In some cases, however, the mucous membrane of the prostatic urethra is highly sensitive to the passage of instruments, and considerable bleeding takes place. In such cases I am in the habit of using a weak astringent in the washings—say ¼ grain of acetate of lead to the ounce—and winding up the proceedings with a stronger solution.

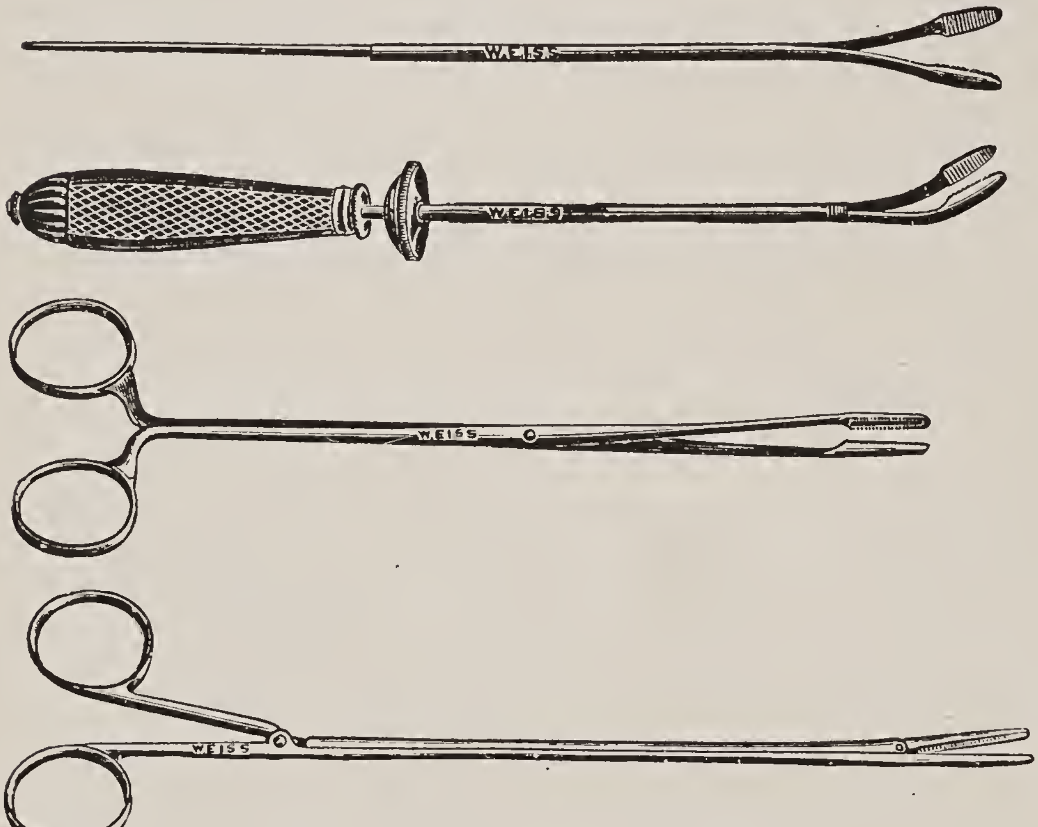

Fig. 374. Urethral Forceps.

After-treatment. The operation being completed, the patient should be put to bed, and well wrapped up in warm clothing. A morphia suppository should be at once introduced. The food for the first few days should be of a light kind, consisting mainly of milk and soups. A demulcent and alkaline drink should be allowed.

For the first twenty or thirty hours the urine may be tinged with blood, particularly till the operator has had large experience in this branch of surgery, and there will, as a rule, be considerable burning sensation along the course of the urethra, with some difficulty of micturition. Should there be any pain or tenderness on pressure in the region of the bladder, hot fomentations assiduously applied to the hypogastric region will also be found soothing; and pain in the perineal region will be lessened by fomenting these parts.

Complications. Retention of urine is a rare sequel of the operation, for which a hot hip-bath will be found most effectual. Should this fail, recourse must be had to the catheter. More rare still is total suppression of urine, which should be dealt with on general medical principles. This occurs only in patients whose kidneys are diseased, and is of very grave import.

When the patient is the subject of enlargement of the prostate, it may be advisable to pass and tie in a soft catheter for a few days, to allow the water to flow in this way.

Acute inflammation of the testicle is a sequel of the operation that has from time to time occurred in my practice, and readily yielded to the ordinary treatment for that complication.

The most frequent sequel of the operation is the occurrence of the ordinary catheter or urethral fever, long recognized as attending the passage of instruments through the urethra, and the supervention of this fever is a contingency that will have to be reckoned with in a considerable proportion of the cases dealt with. The attack sets in, as a rule, a few hours after the operation, frequently after the first act of micturition, and passes through the usual stages—cold, hot, and sweating—of an ordinary attack of intermittent fever, from which it is scarcely to be distinguished. The treatment will also be the same as in ague—extra warm clothing, hot-water bottles to the extremities, and the administration of hot drinks, particularly tea, during the cold stage. As this passes into the hot stage, part of the clothing must be removed, and the patient's thirst relieved by copious drinks of water, lemonade, &c. The ordinary diaphoretic mixture should also be given to encourage perspiration. When the sweating stage sets in, warm clothing must be again supplied to encourage perspiration, and prevent the patient catching cold. During the intermission quinine should be given. The fever is, as a rule, very amenable to treatment.

The beginner will do well to commence by operating on cases where the stone is small and the urethra capacious. As experience is acquired, large calculi and those attended by complications are to be attacked.

Previous to undertaking the operation for the first time it will be well, when possible, for the surgeon to pay a visit to one of those hospitals where the operation is performed. More information will be gained by seeing the operation once well performed, than by any amount of reading and theoretical knowledge.

The length of time occupied by the operation will vary, of course, with the size and consistence of the stone, the capacity of the urethra, the facility with which the instruments can be introduced, and the experience and dexterity of the operator. I am now in the habit of crushing as much of the stone as possible before withdrawing the lithotrite, so that in most cases of stone of ordinary size only one introduction of the instrument is necessary. The repeated introduction of instruments should, I think, be avoided as much as possible. Rapidity of execution is a quality which comes with practice; and there is no doubt that, all undue haste and roughness of manipulation being avoided, it is desirable to complete the operation as rapidly as possible, particularly when the patient is old and much enfeebled by the disease.

The patient is, as a rule, anæsthetized during the operation. During the last few years, I have, however, been performing the operation without an anæsthetic in an increasingly large number of suitable cases. With a capacious urethra in an adult I should not hesitate to attack a stone of about an ounce in weight without the aid of an anæsthetic, or with local anæsthesia by cocaine only, in a case in which the internal administration of an anæsthetic was undesirable, or strongly objected to by a patient.

Difficulties. There are certain complications met with in connexion with the operation of litholapaxy to which I will now direct attention.

Large calculi. With a capacious urethra in an adult male, there being no enlargement of the prostate; and the bladder being roomy and non-sacculated, the experienced litholapaxist should have no difficulty in disposing of a stone of moderate dimensions—say, under 2 ounces in weight. When, however, a stone, if at all hard, exceeds this weight, the operation becomes a much more serious and difficult one. I find that among my series of 1,035 litholapaxy cases there were 37 weighing 2 ounces and upward; 9, 3 ounces or over; and 1, 6⅛ ounces.

The removal of large calculi of these sizes demands much patience, skilful manipulation, and manual labour. It is, indeed, no light or easy task, and will be found to call forth all the resources of the surgeon. Before attacking a stone of 2 ounces and upwards by litholapaxy a surgeon should have considerable experience in dealing with smaller calculi.

After introducing the lithotrite there may be considerable difficulty in grasping the stone between the jaws of the instrument, owing to the walls of the bladder contracting on it, particularly as calculi of these sizes are frequently attended by chronic cystitis, resulting in contracted bladder with thickened walls. To overcome this difficulty as much warm boric lotion as the bladder will retain should be injected before introducing the lithotrite, so as to separate the walls of the viscus from the stone, and thus allow room for manipulating the jaws of the instrument on to it.

It will sometimes be found, in dealing with large calculi, that though the lithotrite will not lock should the stone be first grasped by the long axis, it will do so if this is changed for the short axis of the stone. This manœuvre should always be tried before abandoning the case as unsuitable for litholapaxy. And here I may mention that experience has taught me that, as a rule, a stone lies in the bladder with its long axis in the antero-posterior direction.

When we have to deal with a phosphatic stone of such size that the largest lithotrite that the urethra will admit cannot lock on it, the jaws of the instrument should be dug into its sides and then screwed home, this process being repeated over and over again. In this way we can, by scraping its surface, and chipping off portions, if the calculus be irregular in shape, frequently reduce it to such dimensions that the lithotrite can lock on it, when it is easily disposed of.

Urethral stricture. Of all the complications met with in the treatment of stone by litholapaxy, the most difficult to deal with is, perhaps, the presence of organic stricture of the urethra. To permit of the large instruments employed in this operation passing through the urethral canal, the stricture must first of all be disposed of. This will be accomplished by either internal urethrotomy or dilatation, according to the nature of the stricture. If the case be one suitable for dilatation—that is to say, if the stricture be soft, elastic, and dilatable—this is best done by passing rapidly in succession a series of conical steel sounds (see Fig. 368) two or three times larger at the bend than at the point, till the canal is sufficiently dilated; and then at once introducing the lithotrite and disposing of the stone. If the stricture be tight but dilatable, it will be well to commence its dilatation a couple of days before the operation by tying in gum-elastic catheters of successively larger sizes till No. 8 or 10 is reached, and then, on the day of the operation, completing the dilatation by large conical steel sounds rapidly passed in succession. If, however, the stricture be hard, fibrous, and non-dilatable, it must be dealt with by internal urethrotomy immediately before the operation for the stone.

Hypertrophied prostate. Enlargement of the prostate is a complication which, contrary to what might be expected, as a rule offers little obstruction to the performance of litholapaxy. In passing the instruments over the enlarged prostate a little extra manipulation may be necessary. When obstruction is met with in the prostatic portion of the urethra, I find the manipulation of depressing the handle of the lithotrite between the thighs, and pushing it onwards with a slightly rotatory or boring motion in the direction of the axis of the body, frequently successful in entering the bladder. Should this fail, it will be necessary for the surgeon to change from the right side of the patient to the left, and, by means of the forefinger of the left hand in the rectum, holding the lithotrite in the right, to endeavour to guide the point of the instrument over the obstruction into the bladder.

When considerable hypertrophy of the prostate exists, and particularly when there is a median outgrowth, owing to its projection into the bladder, there is naturally a pouch formed between the posterior surface of this organ and the base and posterior wall of the bladder. It is in this pouch that, as a rule, the stone lies; and, in order to catch it there, it will frequently be necessary to turn the jaws of the lithotrite round so as to point downwards, and then to open them in this position, when, by a little manipulation, the stone, and subsequently its fragments, will be caught.

When the patient is dependent on the catheter, care must be taken to draw the urine off three or four times daily after the operation; or a soft rubber catheter may be tied in and the urine allowed to flow by this for a few days.

There is generally a good deal of bleeding during the performance of litholapaxy when the prostate is enlarged. It is necessary in such cases to exercise great care in removing the last fragments, for they frequently get embedded in clots of blood in the bladder, which have to be broken up by frequent washings by the aspirator, and then removed with the entangled débris of stone.

We must not expect, however, to be successful in performing litholapaxy in every case in which hypertrophy of the prostate occurs in connexion with stone in the bladder. It will occasionally be found that, even when a large steel sound can be passed readily into the bladder in such cases, no amount of manipulation will enable us to pass a lithotrite, with its sharply curved back. The use of force of any kind in passing instruments in such cases must be carefully avoided; and if the lithotrite cannot be coaxed in by that amount of manipulative skill which the surgeon from his experience has acquired, the idea of performing litholapaxy must be abandoned, and suprapubic or perineal lithotomy had recourse to, according to the circumstances of the case.

With the brilliant success now attending the operation of enucleation of the enlarged prostate, it is rare indeed that the surgeon will stop short at litholapaxy in such cases, the operation of choice being the removal of the stone suprapubically, followed at once by enucleation of the prostate. Still, cases will occasionally occur in which conditions of general health may contra-indicate the more radical operation, but in which removal of the stone by litholapaxy may be advisable, to ameliorate the painful symptoms due to this cause.

Partially impacted calculus. A difficulty is sometimes met with, both in passing instruments and catching the stone, when the calculus lies stationary, growing partly in the bladder and partly in the prostatic portion of the urethra. From one's experience of lithotomy, the difficulty of managing such cases may be easily imagined. Every lithotomist of any experience must have come across cases in which an irregular, elongated calculus lies with its main portion or body in the bladder, and a small elongated head in the prostatic urethra, the two portions being united by a neck corresponding with the vesical orifice of the urethra (see Fig. 375). Such a calculus must, if possible, be displaced from its position backwards into the bladder before being crushed; otherwise lithotomy will have to be performed.

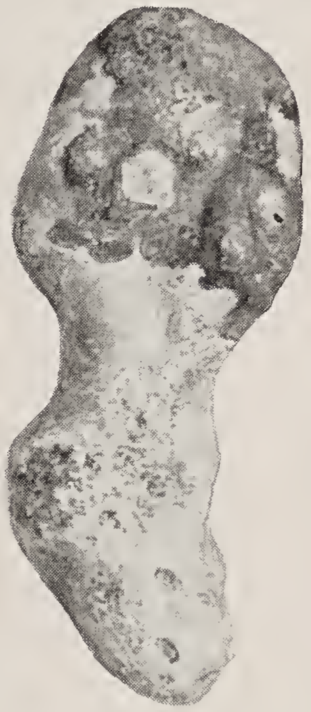

Fig. 375. Calculus partly Vesical and partly Urethral. The neck of the bladder gripped the constricted portion.

The manœuvre by which this is accomplished is as follows: The largest canula that the urethra will admit is passed as far as the stone lying in the prostatic portion of the canal. The aspirator is then applied, and water pumped with force into the bladder. The force of the stream dilates the prostatic urethra, which thus loosens its grip on the stone and the latter is displaced backwards into the bladder, where it is disposed of by the lithotrite.

IN MALE CHILDREN

For the performance of litholapaxy in male children it is essential that the surgeon should be provided with a series of small fully fenestrated lithotrites of the same patterns as those used for adults, but varying in size from No. 4½ to 10. It will be found that in boys aged from thirteen to sixteen years a lithotrite of size No. 11 or 12 will pass readily as a rule. The canulæ employed are also similar in shape to those used for the adult, but vary in size from No. 6 to 11, English scale. The smaller sizes should not be more than 7 inches in length, as the return stream through these small canulæ is very weak, and diminishes in strength with the length of the tube. The aspirator is the same as for adults; but it must, of course, be worked very gently, only a small quantity of water, proportional to the size of the bladder, being thrown in. Any smaller or weaker apparatus will not suffice to extract débris through the narrow canula, owing to the stream being so feeble.

It will be found that the capacity of the urethra in patients of the same age varies much more in children than in adults. Thus, the urethra of a child of five or six years of age will frequently be found to admit a No. 10 lithotrite with ease; in other instances a No. 6 is passed with difficulty.

The meatus of the urethra in children is, as a rule, very narrow, and frequently requires to be enlarged to permit the litholapaxy instruments to pass. The incision should be on the floor of the urethra.

I find that in children, after the meatus has been enlarged, the first 2 inches of the urethra is, as a rule, the narrowest and most difficult part through which to pass the lithotrite; whereas in adults the difficulty, when one occurs, lies generally at the triangular ligament or prostatic portion of the canal.

In children the operation is, for the same size of stone, a much more tedious one than in the adult, owing to the small size of the instruments employed, and the necessity to grind the calculus into very fine débris before it will pass through the canula.

There is more danger of a fragment of stone being left behind in children than in adults. The stream passing through the small tubes employed has not the same evacuating force as in the larger canulæ used in adults. The débris is not, therefore, carried with the same certainty towards the eye of the canula from the various parts of the bladder; and the fragments do not give out the diagnostic clicking sound so clearly. It is therefore necessary to institute a very careful search by pumping in water and exhausting it, with the eye of the canula turned in various directions, before the instruments are finally withdrawn. In the hands of a careful and experienced surgeon there is little chance of a fragment being left behind.

Litholapaxy should not be attempted in a child when the smallest lithotrite at hand is a tight fit for the urethra. When the instruments fit tightly at first, there may be some difficulty in their reintroduction, or even in their withdrawal, owing to the congestion and swelling of the urethral mucous membrane that takes place near the meatus. I have noticed this phenomenon, but to a much slighter extent, in young adults, but never in old men.

When the urethra in a male child is capacious, and the calculus of moderate size, litholapaxy can be performed with facility; but when the urethra is very narrow, or the stone large, the operation is a difficult one. In any case, litholapaxy in male children is a much more delicate one than in the adult. I do not think that a surgeon would be at all justified in attempting this operation in a male child till he had had very considerable experience of it in the adult.

If it was necessary to caution the surgeon against the use of force in passing instruments in the adult, this is doubly necessary in the case of children, in whom the mucous membrane and other tissues are so delicate and easily lacerated.

IN FEMALES

Litholapaxy in females is, as a rule, not a difficult proceeding, the instruments employed being the same as for males. Even quite young female children admit large lithotrites and canulæ without any preliminary dilatation of the urethra. The only special difficulty met with is that, owing to the width and shortness of the urethral canal, the water which is necessary in the bladder during the crushing of the stone is liable to rush out beside the instruments. This difficulty is obviated by getting an assistant to place the fore and middle fingers of one hand in the vagina, and to press the posterior lip of the urethra against the lithotrite or canula, a manœuvre which prevents the water from flowing out. Litholapaxy in females is eminently successful, and the patient may be seen, as a rule, walking about the day after the operation. No forcible dilatation of the urethra being necessary, there is no incontinence of urine, that extremely troublesome sequel which sometimes follows the operation by dilatation.

CHAPTER XIV

LITHOTOMY

The patient is prepared by having his bowels thoroughly cleared out by a purgative, in addition to which an enema is given a couple of hours before the operation. The perineum is shaved and purified, and an antiseptic dressing applied thereto.

LATERAL LITHOTOMY

Operation. The patient is placed on an operating table of convenient height and anæsthetized. A gum-elastic or rubber catheter is then introduced, the urine drawn off, and the bladder washed out with warm boric lotion till this flows clear. Six or seven ounces of the lotion are left in the bladder on withdrawal of the catheter. A staff of this shape (see Fig. 376), with a deep groove extending along the left side of the curved portion to within an inch of its point, and of the largest size that the urethra will readily admit, is then passed into the bladder, when the stone should be felt. Should the staff fail to reveal the presence of the stone, it must be withdrawn and a sound introduced to ascertain the position of the stone. On reintroduction of the staff the stone will be located. But on no account should the operation be proceeded with till the stone is definitely felt by the staff, lest the latter may have failed to reach the bladder, owing to its possible diversion into a false passage in the urethra.

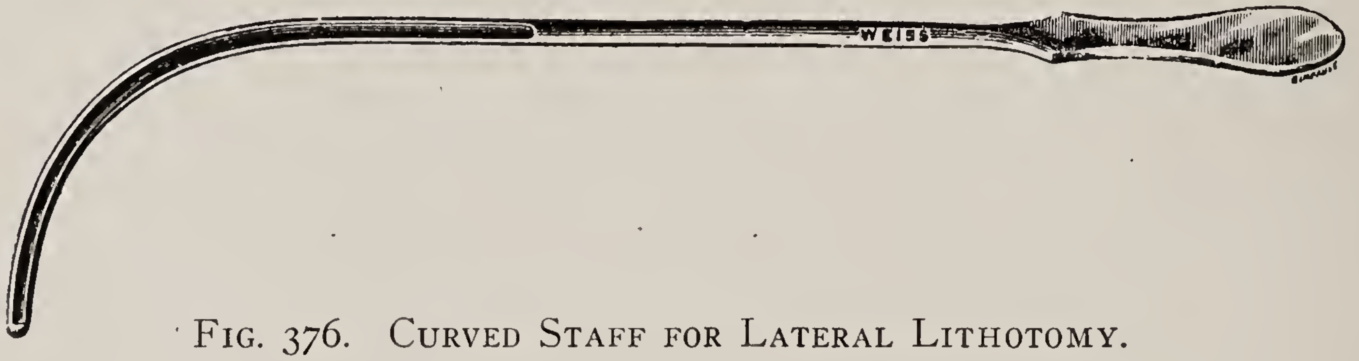

Fig. 376. Curved Staff for Lateral Lithotomy.

The patient is now placed in what is called the 'lithotomy position' (see Fig. 377), that is, on his back with his thighs flexed on the abdomen and the legs flexed on the thighs, and with the buttocks projecting somewhat beyond the end of the table. He is held in this position by an assistant on either side. It was formerly the practice to bind the patient's hands and ankles together on either side, and in recent years a Clover's crutch has been employed for keeping the lower limbs in position. All these appliances savour of pre-anæsthetic days, when it was necessary to secure the patient from struggling during the operation. They one and all interfere with the introduction and securing of the staff in position, and hamper the patient's breathing. There is no fixation arrangement equal to the aid of a couple of skilful assistants for this purpose, who can extend or flex the patient's limbs as required, and keep the parts symmetrically placed during the operation.

The staff is placed with the shaft perpendicularly and the concave aspect of the curved portion pressed against the roof of the urethra, beneath the pelvic arch, and then relegated to an assistant standing on one side, who with the second hand raises the scrotum up out of the field of operation.

The surgeon passes a finger into the rectum to ascertain that it is empty and acquire a knowledge of the size and general conformation of the prostate. Having purified his finger, he sits on a stool of convenient height facing the patient's perineum, and passes the fingers along the bony arch of the pelvis so as to take in a mental grasp of the relative positions of the various structures.

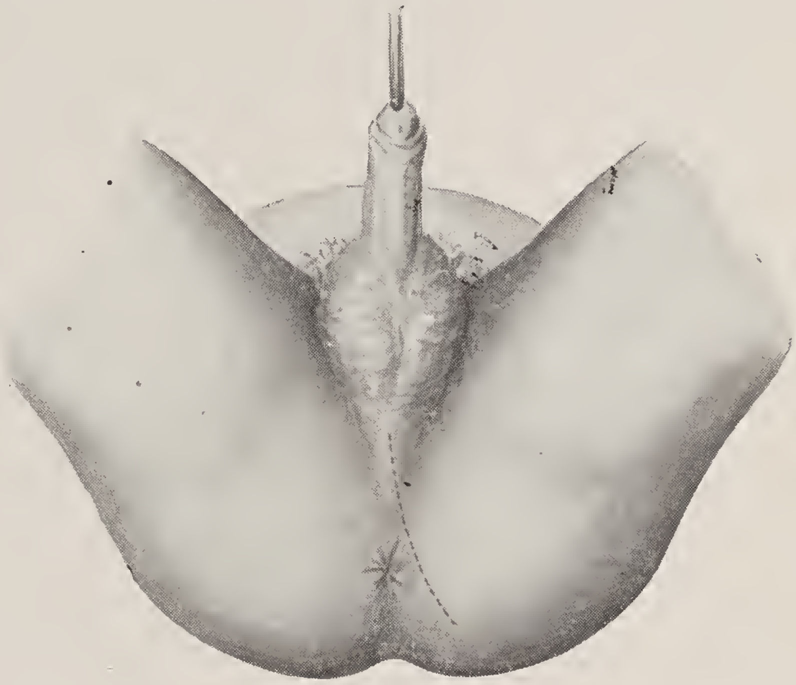

FIG. 377. THE SUPERFICIAL INCISION IN LATERAL LITHOTOMY. (*Fergusson.*)

The point of the knife (see Fig. 378)—one with a stout blade 3 inches long, and with a straight back—is then entered 1½ inches in front of the anus and slightly to the left of the central raphe, and an incision 2½ to 3½ inches long, according to the stoutness of the patient, boldly made outwards and downwards to about an inch beyond the anus, in such a direction that it intersects an imaginary line drawn from the ischial tuberosity to the anus at the junction of its middle and outer thirds (see Fig. 377). By this incision, which should be deeper towards the centre than at the ends, the skin and subcutaneous tissues are freely divided; but no attempt should be made to reach the staff in the first instance. The knife is applied once or oftener to the exposed fat and cellular tissue, and the forefinger of the left hand is then introduced deeply into the wound between the accelerator urinæ and the erector penis muscles, when the groove in the staff will be felt at the membranous portion of the urethra. The finger-nail is fixed in the groove as far back as possible to protect the bulb. The blade of the knife is then passed along the back of the finger with its edge directed outwards and downwards, and the membranous urethra incised, so that the point of the knife is felt grating against the groove of the staff (see Fig. 379). Keeping the point of the knife carefully in the groove, it is pushed along till it reaches the bladder, cutting through the side of the urethra and notching the left lobe of the prostate. On withdrawal of the knife the incision is enlarged downwards and outwards to an extent proportionate with the estimated size of the stone.

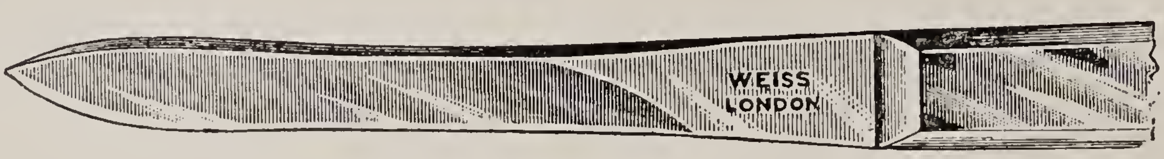

FIG. 378. SHARP-POINTED LITHOTOMY KNIFE.

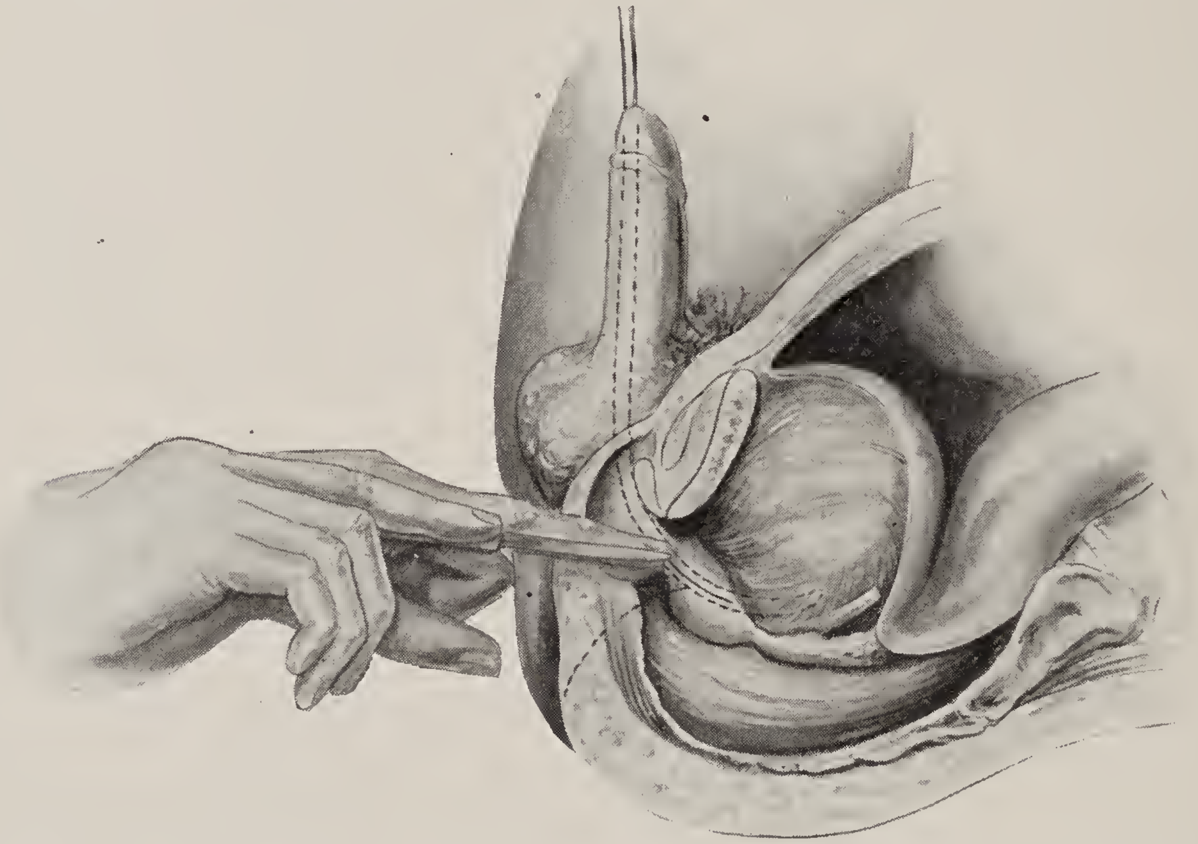

FIG. 379. THE DEEP INCISION IN LATERAL LITHOTOMY. (*Fergusson.*)

The forefinger of the left hand is then passed along the staff into the bladder, dilating the wound in its progress. When the surgeon is assured that the finger has reached the bladder, either by his feeling the stone, or by the sensation of its lying in a large smooth-walled cavity, the staff is withdrawn. The neck of the bladder and the deep wound are then further dilated by twisting the finger about, and the stone located, if it has not already been felt lying, as it usually is, close up against the inner orifice of the urethra.

Forceps of the type seen in Fig. 380—of which several pairs of various sizes, some straight and others curved with spoon-shaped blades roughened on the concavity, should be at hand—are then passed along the finger, and as the point enters the bladder the finger is slowly withdrawn, and the blades are at the same moment opened, when a gush of lotion will take place, and frequently the stone be carried into the jaws of the instrument. Should the stone not be thus caught at once the instrument is moved about in search of the stone, the blades being gently opened and shut, over and over again, perhaps, till the stone is secured. Before attempting to withdraw the stone the forceps are moved about in the bladder to ascertain that they are free, lest a fold of the mucous membrane should be engaged in their grip.

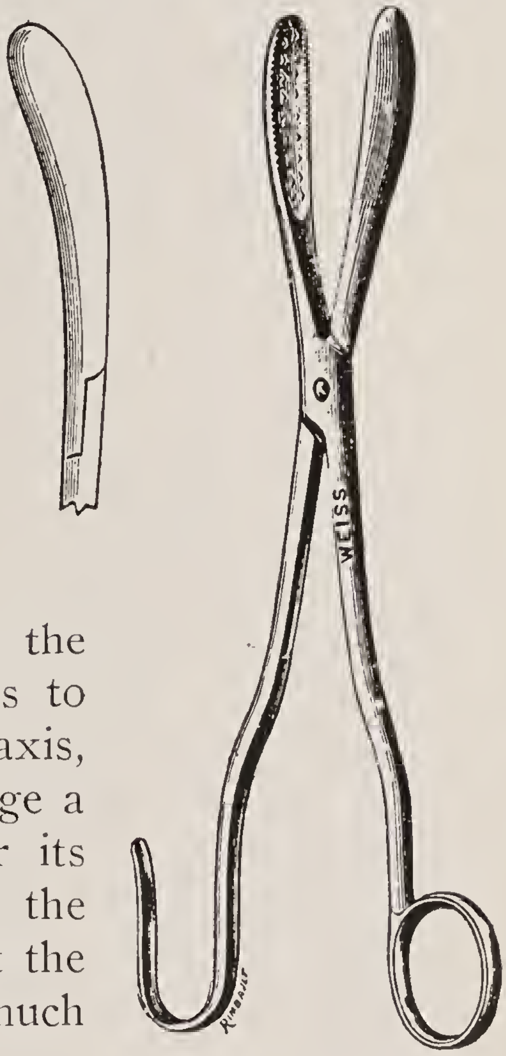

Fig. 380. Lithotomy Forceps.

The forceps, with the contained stone, are then gently withdrawn by a side-to-side alternating with a rotatory movement, downwards and backwards first and then forwards and upwards, in the axis of the pelvic outlet, avoiding pressure on the upper aspect of the urethra beneath the pelvic arch. If there be much obstruction to its advance the finger should be introduced beside the forceps to ascertain that the stone is grasped by its long axis, if it be an elongated one. If the stone be large a certain amount of force will be required for its extraction, but enlargement of the wound by the knife is preferable to bruising of the tissues at the neck of the bladder by the employment of much force.

On the removal of the stone the finger should be reintroduced and the bladder thoroughly explored to ascertain if a second or more calculi be present. Pressure on the hypogastrium with the other hand will bring the distal portions of the bladder within reach of the finger.

If the stone be broken during extraction, as is frequently the case when phosphatic, or if several small calculi be present, a scoop (see Fig. 381) will be found more convenient than forceps, the débris or calculi being held between the scoop and the tip of the forefinger in extraction.

There may be considerable hæmorrhage from the superficial perineal arteries, the deep branches of the pudic, particularly that which courses inwards to the bulb, or from the prostate. Superficial vessels are ligatured, and the deep ones also when practicable; should there be any difficulty about this, catch-forceps may be applied and left in position for a day or two. Prostatic bleeding is best arrested by introducing a large stiff rubber drainage tube, and packing the wound around this with iodoform gauze if necessary. I have seen very profuse hæmorrhage into the bladder in my early lithotomy days in old men with enlarged prostates. Such cases are now, of course, treated by suprapubic removal of the stone and prostate.

The operation as just described is that which I practised in my early lithotomy days in India. Later on I abandoned the curved staff in favour of a practically straight one (see Fig. 382), resembling Key's, save that the end is somewhat more curved for facility of introduction. The groove is median and extends just as far as the bend.

Further, after making the superficial incision in the perineum I assume charge of the staff, holding it in my left hand whilst I pass the knife along its groove into the bladder. The sympathy between the two hands enables one to judge of the position of the groove, and at once strike it off with the point of the knife.

Some surgeons are in the habit of laying aside the sharp-pointed knife when the groove in the staff has been reached and completing the incision by means of a probe-pointed knife (see Fig. 383) slid along the groove, by this means obviating the possibility of injuring the bladder with the point of the scalpel. For the novice this is a wise precaution, but unnecessary for the practised lithotomist, particularly if the bladder contains a considerable quantity of fluid, as it always should do before commencing the operation.

If the patient be very stout or the prostate enlarged, the finger may fail to reach the bladder. A gorget with blunt edges (see Fig. 384) is in such cases passed into the bladder along the groove of the staff, which is then withdrawn, and the forceps introduced along the concavity of the gorget.

An imperative precaution during this operation is, *always to have some guide in the bladder (whether staff, gorget, or forceps) and never to withdraw one till another is fairly in that viscus.* Otherwise you may fail to reach the bladder, an unfortunate accident likely to be attended by disastrous results.

The rectum is liable to be wounded during this operation. This accident is obviated by taking care that the lower bowel is thoroughly emptied before the operation, by keeping the staff well up against the pubic arch, and by directing the edge of the knife outwards, away from the anus in the direction already indicated. Should this accident occur, the wound is simply allowed to granulate without any active interference.

The operation being completed, a stout perineal drainage tube of stiff rubber (see Fig. 385) is inserted in the bladder, and retained in position by means of a suture of silkworm-gut passed through it and the margins of the wound. The edges of the wound, if extensive, may be partially brought together by means of a suture or two. The bladder is then washed out through the tube with warm boric lotion to remove any clots of blood or grit that may be lying there. The tube is removed in the course of three or four days, when the urine passes by the wound for some days. The surface of the wound will have begun to granulate and be covered by plastic lymph, thus preventing absorption from septic urine. Urine will begin to pass by the urethra at periods varying from one to three weeks. In aged patients, the subjects of prostatic enlargement, the period was much longer; but cases of this kind would now, as already explained, be dealt with suprapubically.

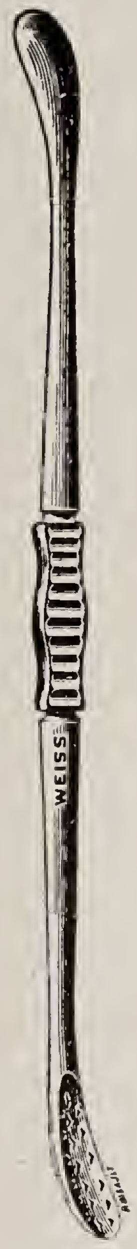

Fig. 381.
Lithotomy Scoop.

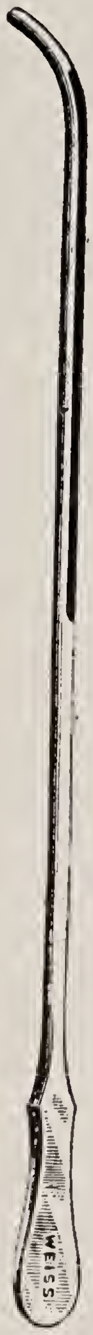

Fig. 382.
Straight Lithotomy Staff.

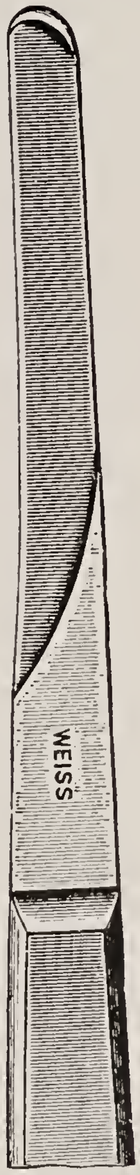

Fig. 383.
Probe-pointed Lithotomy Knife.

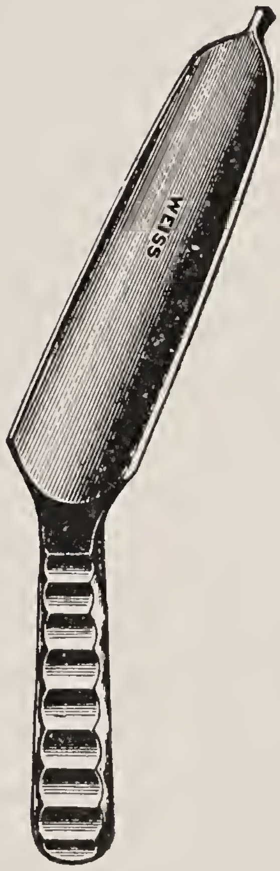

Fig. 384.
Blunt-edged Gorget.

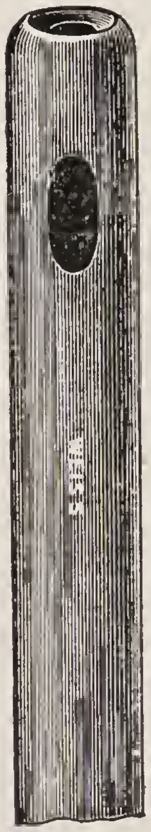

Fig. 385.
Perineal Drainage Tube.

The bed in which the patient is placed is, of course, protected by waterproof sheeting, and absorbent cotton-wool and cellulose thickly packed beneath the buttocks and along the perineum, being kept in position by a broad bandage. The dressings should be changed every three or four hours, when saturated with urine. The usual precautions should be taken to prevent the skin in proximity to the wound getting irritated by the urine.

The operation in male children. In male children the largest staff that can be introduced with facility should be employed. Owing to the undeveloped condition of the parts and the delicate nature of the tissues there may be some difficulty in introducing the finger into the bladder, and if force be used the prostate and bladder may be pushed off the urethra up into the pelvis. To obviate such an occurrence a small blunt gorget should be passed along the staff into the bladder, and by this the wound is dilated. On withdrawal of the staff the finger can be introduced, or the forceps, which should be very slender, can be slipped along the gorget into the bladder.

In children a tube is unnecessary and irksome. The urine is allowed to flow by the wound from the first. Granulation takes place rapidly in them, so that the wound is frequently completely closed in a week or ten days.

MEDIAN LITHOTOMY

For this operation a curved staff with central groove is generally employed. An incision is made through the skin and subcutaneous tissues in the central line of the perineum, commencing 2 inches in front of the anus and extending downwards almost to its edge, merely cutting through the skin at the lower part of the wound. The forefinger of the left hand is then passed deeply into the wound and the groove of the staff is felt in the membranous portion of the urethra. The point of a long, slender, straight bistoury, with its edge downwards, is passed along the finger till it enters the groove of the staff and is then slid along it, cutting through the membranous urethra and nicking the apex of the prostate. No extensive wound of the prostate is necessary or desirable, as the prostatic portion of the urethra is roomy, and dilatable by the finger to such dimensions as will permit the withdrawal of any stone that can be removed by this method.

A blunt-edged gorget (see Fig. 384) is passed into the bladder along the groove in the staff, which is then withdrawn. The finger is now passed into the bladder along the gorget, which is in turn withdrawn. Then the forceps are passed along the finger, and the stone caught and removed as already described in connexion with the operation of lateral lithotomy.

Personally I always use the straight staff (see Fig. 382), which I hold in my left hand, and at once enter the knife straight into its groove, without any preliminary incision of the skin, cutting through the superficial parts as the knife is withdrawn.

A rubber perineal tube is tied in the bladder for two or three days, after which the urine is allowed to flow by the wound till it closes. The after-treatment is the same as for lateral lithotomy.

Only calculi of comparatively small sizes can be removed by this method, and such are best dealt with by litholapaxy. This operation should be reserved mainly for those cases in which the stone is impacted in the prostatic urethra, or growing partly there and partly in the bladder (see Fig. 375), and which cannot be dislodged backwards into the bladder for removal by litholapaxy.

There is scarcely any bleeding unless the bulb is encroached on during the incisions.

The operation is frequently performed by inserting the knife with its back downwards in front of the anus, and cutting in an upward direction on the staff, the forefinger of the left hand being placed in the rectum. I consider the other method superior.

SUPRAPUBIC LITHOTOMY

Operation. The operation of suprapubic cystotomy, by which the stone is reached and extracted, will be found described in detail on p. 618. The bladder having been opened, the stone is located by the left index-finger. Lithotomy forceps (see Fig. 380) are then introduced; the stone is caught between the blades, and gently withdrawn through the wound.

The extent of the wound in the bladder will depend on the size of the stone. Should it be necessary to enlarge the wound first made by the knife, this is best done by introducing the two index-fingers and gently tearing the bladder-wall by separating them to the required extent. In this way hæmorrhage is reduced to a minimum. It is better to enlarge the wound than to use undue force in extraction of the stone, by which the bladder-wall would be bruised, thus probably leading to sloughing of the tissues.

When the stone is small, or if several be present, the scoop (see Fig. 381), aided by the point of the index-finger in the bladder, will be found more efficient than forceps. Should the calculus be phosphatic it will probably break up during extraction, in which case all the débris must be carefully removed by the scoop, and by flushing out the bladder with warm lotion.

On completion of the operation a stout drainage tube is introduced into the bladder and fixed in position by a suture. Around this the edges of the abdominal wound are loosely brought together; and, speaking generally, the after-treatment is similar to that already described in connexion with suprapubic cystotomy (see p. 622).

RESULTS OF OPERATIONS FOR VESICAL STONE

The late Sir Henry Thompson collected details of 1,827 lateral lithotomies performed in British hospitals previous to the introduction of the operation of litholapaxy, showing 229 deaths, or a mortality of 12.53%. Amongst these there were 799 adults, with 161 deaths, or 20.15%, and 1,028 children, with 68 deaths, or 6.61%.

In a paper published in the *Lancet,* March, 1885, I gave statistics of 2,592 lateral lithotomies performed in Indian hospitals in 1882, when litholapaxy was scarcely practised in that country, showing a mortality of 13% on the whole—practically the same as in British hospitals.

Sir Henry Thompson had 1,007 operations for vesical calculus in his own practice, amongst which there were 136 perineal lithotomies, with 44 deaths, or 32.35%, viz. 115 in adult males, with 42 deaths, or 36.52%; 12 in male children, with 1 death, or 8.33%; and 9 in females, with 1 death, or 11.11%.

There were 19 suprapubic lithotomies, with 5 deaths, or 26.31%.

There were 850 lithotrities, with 49 deaths, or 5.76%, viz. 844 in adult males, with 49 deaths, or 5.80%, 3 male children and 3 females being successfully operated upon.

Rapid dilatation of the urethra was the method of removal employed by him in 2 females, both successfully.

Sir Henry explains the high mortality from lithotomy in his practice by the fact that the worst cases were treated by cutting operations, lithotrity being employed in the less serious ones.

Furthermore he draws attention to the fact that of the crushing operations 472 were done by the old method of lithotrity by repeated 'sittings,' with 37 deaths, or 7.83%, whereas 372 were done by lithotrity at one sitting (Bigelow's operation), with 12 deaths, or 3.22%.

In my own practice I have performed 1,443 operations for stone in the bladder. Amongst these there were 255 perineal lithotomies with 11 deaths, viz. 55 adult males, with 10 deaths, or 18.20%, and 200 male children, with 1 death, or 0.50%.

There were 149 suprapubic lithotomies, all in adult males, with 19 deaths, or 12.75%. In 110 of these enucleation of the enlarged prostate was performed at the same time, with 14 deaths, or 12.75%, and though, as previously stated, all these deaths are accepted in connexion with the latter operation, they are here again set down to the suprapubic lithotomy for statistical purposes. It is a remarkable fact that in my practice suprapubic lithotomy with enucleation of the prostate at the same time is not accompanied by a higher mortality than simple suprapubic lithotomy alone.

There were 1,035 litholapaxies, with 27 deaths, or 2.61%, viz. 815 in adult males, with 25 deaths, or 3.06%; 192 in male children, with 2 deaths, or 1.04%; and 28 in females, all successful.

Vaginal lithotomy was performed in 1 female and removal of the stone by dilatation of the urethra in 3, all with success.

Of my 1,443 operations for stone, 864 were done in India and 579 in England. The mortality in both countries is practically the same.

From 1864 to 1908 inclusive there were 1,560 operations for stone in the bladder performed at St. Peter's Hospital, and the introduction of litholapaxy has been followed by a gradual decline in the death-rate from 15.25% in the first decade to 3.87% in 1904–8. In 1908 the mortality was only 1.61%.

SECTION VI

OPERATIONS UPON THE GENITO-URINARY ORGANS

PART IV

OPERATIONS UPON THE PROSTATE

BY

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CHAPTER XV

SUPRAPUBIC PROSTATECTOMY

Belfield of America must be credited with the first rational attempt, in 1886, at a radical operation for the removal of the obstruction caused by the enlarged prostate to the natural flow of the urine; but the operation became best known in England in connexion with the name of McGill of Leeds, who, in 1888, brought it prominently to the notice of the profession. The operation consisted in opening the bladder suprapubically and removing the prominent portion of the prostate in the viscus. It was, however, merely a partial prostatectomy, and after enjoying a temporary popularity fell out of practice, owing to the high mortality attendant thereon, and to the fact that in a large proportion of the cases there was no improvement on the previous condition.

INDICATIONS FOR PROSTATECTOMY

When there is decided enlargement of the prostate in a person of advanced age giving rise to urgent symptoms necessitating the employment of a catheter as a daily routine for emptying the bladder of its residual urine, the operation of prostatectomy should be entertained and advocated, provided the growth be of such a nature that it is capable of being enucleated entire and that there be nothing in the age of the patient or in his general state of health to contra-indicate an operation of this magnitude.

In the great majority of cases referred to the consulting surgeon, the catheter will have been employed for weeks, months, or years, and in a large proportion of them the reference will be made owing to the supervention of one or more of the usual complications incident to so-called 'catheter life,' viz. recurring cystitis, hæmorrhage, formation of vesical calculus, difficulty in introducing a catheter, &c., and in which there is practically no alternative but an operation. But prostatectomy is now attended by such a low mortality and such excellent subsequent results that the habitual use of the catheter should be anticipated, or at least the operation should be undertaken as early as possible after the use of the catheter becomes necessary, before the complications above referred to set in. When undertaken whilst the patient's general health is sound, and before the advent of local complications, there is practically no danger in the operation in experienced hands. When these complications set in, as they invariably do sooner or later, and particularly when the kidneys become affected through the backward pressure of the urine, or through ascending pyelitis, the operation must necessarily be attended by considerable risk.

There is another consideration that should strongly weigh in favour of early operation, viz. that recent experience has demonstrated beyond doubt that the adenomatously enlarged prostate has a tendency in a large proportion of cases to assume a cancerous type under the irritating influence of the catheter and complications incidental to its habitual use.

To ascertain whether the prostate is capable of being enucleated entire in its capsule, the patient, if capable of passing any urine naturally, is directed to empty his bladder as far as possible, and is then placed on a couch in the recumbent position. The bladder is emptied of its residual urine by means of a catheter. The forefinger of one hand, previously lubricated, is slowly introduced into the rectum, and when the sphincter ani is thoroughly relaxed a survey of the rectal aspect of the prostate is made. If the organ be found to be decidedly enlarged, presenting a well-marked tumour in the rectum more or less rounded in shape, bilobed laterally, with a well-marked furrow in the median line, smooth on the surface, soft or somewhat dense to the touch, and (most important of all) movable, we know that we have to deal with the ordinary adenomatous enlargement of the gland of advanced life. If, in addition, from its prominence in the rectum we estimate the tumour to be at least of the size of a tangerine orange, the case may be regarded as in all probability one in which the prostate is capable of being enucleated entire.

We next proceed to make a bimanual examination of the prostate. This is accomplished by placing the fingers of the other hand on the hypogastrium and pressing them well down behind the pubic arch, at the same time directing the patient to relax the abdominal muscles. Counter-pressure is made by the finger in the rectum. If the prostate be decidedly enlarged it will be felt between the fingers of the two hands and can be slightly moved upwards, downwards, or from side to side, like a chronically enlarged uterus, but to a less extent. If it be very prominent in the bladder the outgrowth in that viscus will be easily recognized, and in thin subjects the origin of the outgrowth, whether from the right or left lobe, or from both. In thin or moderately stout patients this method of examination is easily accomplished and is most helpful for diagnostic purposes. In very stout patients it is less satisfactory. Occasionally we meet with patients who are unable to relax their abdominal muscles;

in such cases the examination can only be satisfactorily accomplished under the influence of an anæsthetic.

If on bimanual examination the prostate, with the characteristics already described, be felt distinctly, we can at once pronounce the case to be one in which the organ can be enucleated entire in its capsule, no matter what magnitude it may have attained.

It is, however, when we have to deal with adenomatous enlargements of the prostate of smaller dimensions—say, less than 1½ ounces in weight—that the greatest difficulties present themselves as to the possibility of their enucleation entire being practicable. For as the records of my published cases show, we may find complete dependence on the catheter, strange as it may appear, with a prostate weighing 1½ ounces, 1 ounce, or even less. A prostate of 1 ounce in weight will scarcely feel enlarged *per rectum,* or even bimanually, unless the patient be very thin. The only way we can determine with certainty the possibility of enucleating a prostate of this size is by the aid of the cystoscope. If on cystoscopic examination we find that there is a well-defined outgrowth of one lobe, or marked prominence of both lobes in the bladder, the case may be pronounced to be one permitting of enucleation of the gland entire, no matter what its size may be as felt *per rectum.*

TOTAL ENUCLEATION

In the *British Medical Journal* of July 20, 1901, I described my operation of total enucleation of the enlarged prostate and gave full details of four successful cases, the first of which had been undertaken on December 1, 1900.

Surgical anatomy. The prostate is in reality composed of twin organs, of apparently purely sexual function, which, in some of the lower animals, remain distinct and separate throughout life, as they exist in the human male during the first four months of fœtal existence. After that period, in the human fœtus, they approach each other, and their inner aspects become agglutinated together, except along the course of the urethra, which they envelop in their embrace.

These two glandular organs, which constitute the lateral lobes of the prostate, though welded together, as it were, to form one mass, remain, so far as their secreting substance and functions are concerned, practically as distinct as the testes, their respective gland-ducts opening into the urethra on either side of the verumontanum.

Each of these two glandular bodies, or prostates, is enveloped by a strong, fibro-muscular capsule; and it is these capsules—less those portions of them that dip inwards, covering the opposing aspects of the glandular bodies or lobes, and thus disappearing from view, being embedded in the substance of the prostatic mass—that constitute the true capsule of the prostate regarded as a whole. This capsule extends over the entire organ except along the anterior and posterior commissures, or bridges of tissue that unite the lateral lobes in front of and behind the urethra, thus filling in the gaps between them. This true capsule is intimately connected with the prostatic mass, and is incapable of being removed from it even by dissection.

The urethra, accompanied by its surrounding structures—viz. its longitudinal and circular coats of muscles continued downwards from the bladder, its vessels and nerves—passes downwards and forwards between, and is embraced by, the inner aspects of the two glands or lobes.

The ejaculatory ducts enter the prostatic mass close together in an interlobular depression at the posterior part of its upper aspect, each duct coursing along the inner aspect of the corresponding lobe. They do not penetrate the capsules of the lobes, but pass forwards in the interlobular tissue to open into the urethra.

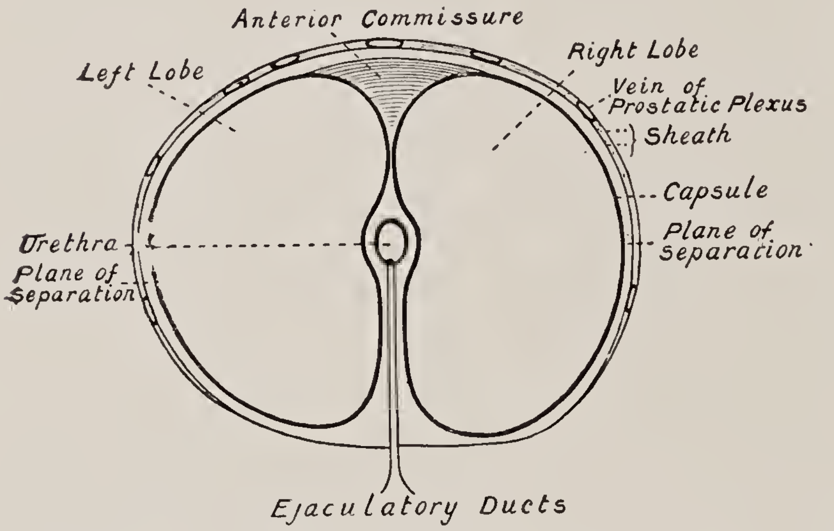

Fig. 386. The Structure of the Prostate and its enveloping Capsules. (*Diagrammatic transverse section.*)

The prostate, thus constituted and enveloped by its true capsule, is further encased in a second capsule or *sheath,* formed mainly by the recto-vesical fascia, numerous connecting bands, however, passing between the two. The nomenclature here adopted is that suggested by the late Sir Henry Thompson in his work *The Diseases of the Prostate,* and is both scientific and practical. Embedded in the outer capsule or sheath, lies the prostatic plexus of veins, most marked in front and on the sides of the prostate. The diagram (see Fig. 386) shows the structure of the prostate and surrounding parts.

There is nothing I can call to mind that illustrates more simply and forcibly the composition of the prostate and its coverings than an orange. If we imagine the edible portion of an orange composed of two segments only, instead of several, with the septum between them placed vertically, we have a rough and homely illustration of the formation of the prostate. The strong fibrous tissue which covers the segments of the orange, and which is intimately connected with the pulp, represents the true capsule of the prostate, the two segments or halves of the orange representing the two lobes. Further, the rind of the orange outside all represents the outer capsule or prostatic sheath formed by the recto-vesical fascia.

And here let me remark that in the operation that I shall presently set forth, it is this inner or true capsule as above described that is removed, the outer capsule or sheath being left behind, thus preventing infiltration of urine into the cellular tissue of the pelvis. The textbooks, as a rule, drew no distinction between the two separate coverings of the prostate, treating them both combined, or the outer one only, as the 'capsule.' To persons brought up in this school of thought and teaching my operation must at first sight necessarily have appeared impossible.

In most, if not all, cases of enlargement of the prostate of declining life (cancer being excluded) the overgrowth is adenomatous in character, numerous encapsuled adenomatous tumours being found embedded within the substance of the lobes, and frequently protruding on their surfaces. They sometimes assume the form of polypoid outgrowths which, however, are invariably enclosed within the true capsule, which is pushed before them.

My ideal operation at the outset consisted in enucleating the enlarged prostate entire in its capsule out of the encasing sheath, leaving the urethra with its accompanying structures behind. But, as will subsequently appear, I discovered at an early stage in the history of the operation that the prostatic urethra might be torn or even partially or entirely removed, with equally good eventual results.

Operation. The pubes having been previously shaved and the parts rendered aseptic, the bladder is thoroughly washed out with an antiseptic lotion, as in this disease the urine is almost invariably foul. The catheter employed for this purpose should be made of rather stiff gum-elastic, and be of the largest size that the urethra will readily admit.

Suprapubic cystotomy is now performed. After washing out the bladder the catheter is left *in situ*, and the viscus is distended with boric lotion. The nozzle of the large syringe employed for this purpose, which is filled with lotion, is inserted in the end of the catheter, thus acting as a plug to prevent leakage from the bladder, and the syringe being ready to further distend the bladder with fluid, if necessary, as the operation proceeds. An incision varying in length from 2½ to 3½ inches, according to the stoutness of the patient and the size of the prostate, is made in the median line of the abdomen, its lower end reaching to the level of the pubic arch. This incision is rapidly carried down through or between the recti muscles till the prevesical space is opened. Any bleeding vessels are clamped by catch-forceps, the forefinger is introduced into the lower angle of the wound, and the prevesical fat scraped upwards off the bladder by the finger-nail for the whole length of the wound. The peritoneum, which should not be seen, is thus pushed upwards out of harm's way, and the bladder appears deeply in the wound, quite tense, glistening, and of a pale white colour, with large and tortuous veins coursing in its substance. Selecting an area devoid of veins, the point of the scalpel is plunged boldly into the bladder, and an incision about 1 inch long is made in the vertical direction toward the symphysis. The wound in the bladder can be subsequently enlarged if necessary; and this is best effected—as being attended by least bleeding—by separating two fingers placed in the wound, and thus tearing the bladder-wall to the required extent. On withdrawal of the scalpel the forefinger is introduced into the bladder as the lotion rushes out through the wound, and a general survey of the viscus is made. Should calculi be present they are at once removed by forceps or scoop.

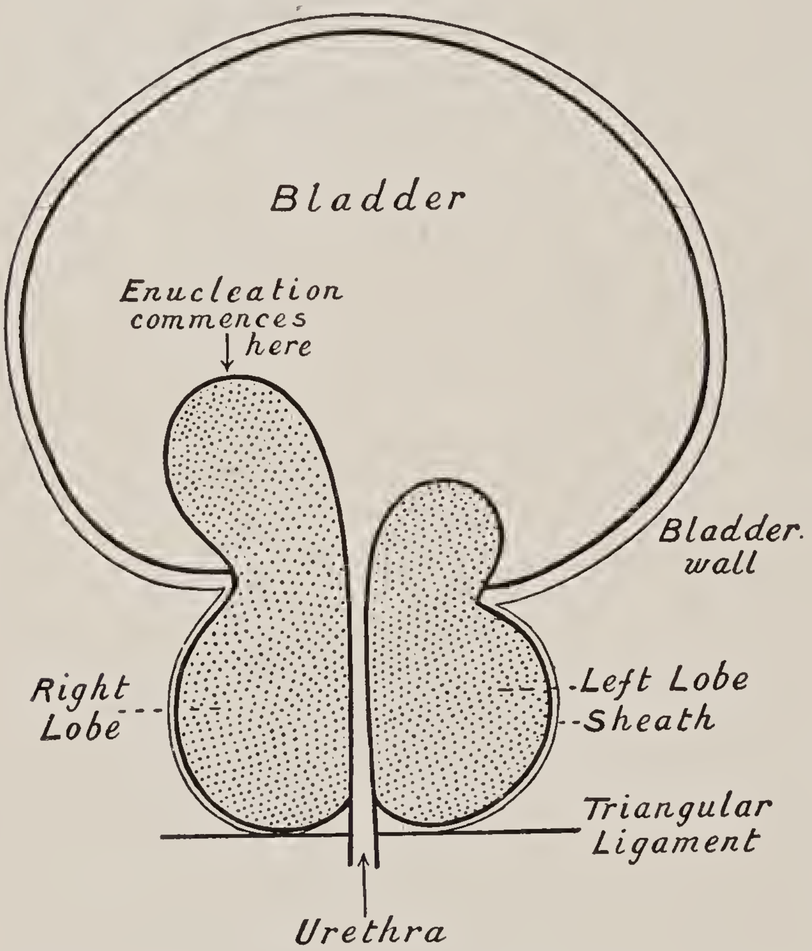

Fig. 387. Horizontal Section of the Prostate and the Bladder. Showing the point at which enucleation commences. (*Diagrammatic.*)

The forefinger of the other hand is next introduced into the rectum to render the prostate prominent in the bladder, and to keep it steady during the manipulation by the finger in the bladder. The mucous membrane over the most prominent portion of one lateral lobe (see Fig. 387), or over the so-called 'middle' lobe if there be but one prominence, is scored through by the finger-nail, and gradually detached by it from the prominent portion of the prostate in the bladder. This portion of the enlarged prostate is covered merely by mucous membrane, so that when this is scraped through and detached the true capsule of the prostate is at once reached.

Keeping the finger's point in close contact with the capsule, the enucleation of the prostate out of the enveloping sheath outside the bladder is proceeded with by insinuating the finger-tip in succession behind, outside, and in front of one lateral lobe, thus separating the capsule from the sheath. The finger is then swept in a circular fashion from without inwards, in front of, and to the inner side of the lobe, detaching this from the urethra, which is felt covering the catheter, and pushed forwards towards the symphysis between the lateral lobes, which will, as a rule, have separated along their anterior commissure in the course of the manipulations. The other lobe is attacked and treated in the same manner. The finger is next pushed well downwards behind the prostate and the inferior surface of the gland is peeled off the triangular ligament. When the prostate is felt free within its sheath and separated from the urethra, with the finger in the rectum, aided by that in the bladder, it is pushed into the bladder through the opening in the mucous membrane, which, during the manipulations, will have become considerably enlarged.

The prostate, which now lies free in the bladder, is withdrawn by strong forceps (see Fig. 388) through the suprapubic wound. And here I may remark that it is astonishing through what a comparatively small wound a very large prostate can be delivered, owing to the elasticity and compressibility of the adenomatous growth between the blades of the forceps. Sometimes the lobes become detached along both anterior and posterior commissures and come away separately.

The question now arises, What becomes of the ejaculatory ducts in the course of this operation? When the lobes come away separately they are probably left behind uninjured, attached to the urethra. When the prostate comes away as a whole, they may be torn across, or pulled out of the gland. But, as will subsequently appear, in the vast majority of my later operations, the distorted portion of the urethra behind the verumontanum has been removed with the prostate, the urethra being severed at the position at which the ejaculatory ducts enter it, the ducts as a rule remaining adherent to the portion of the prostatic urethra that is left behind.

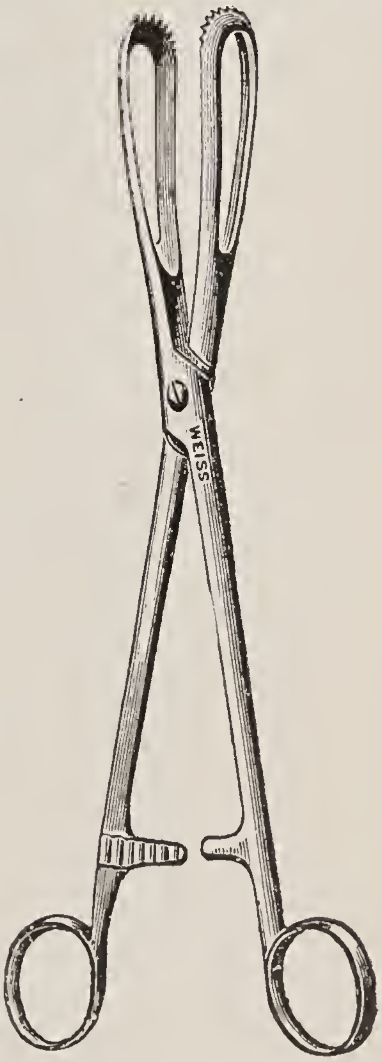

Fig. 388. Forceps for Delivering the Prostate from the Bladder.

Almost from the commencement I have abandoned the employment of any cutting instrument for incising the mucous membrane, finding the finger-nail alone most convenient and expeditious. Besides, when scalpel or scissors are employed there is danger of cutting the capsule, and the guiding line being thus lost, the finger flounders about inside, enucleating isolated adenomatous tumours instead of the whole organ in its capsule.

When I first conceived the possibility of removing the whole prostate, my ideal operation consisted, as already stated, in enucleating the enlarged gland in its capsule out of the enveloping sheath, leaving the urethra behind; and this was the procedure undertaken in my earlier cases.

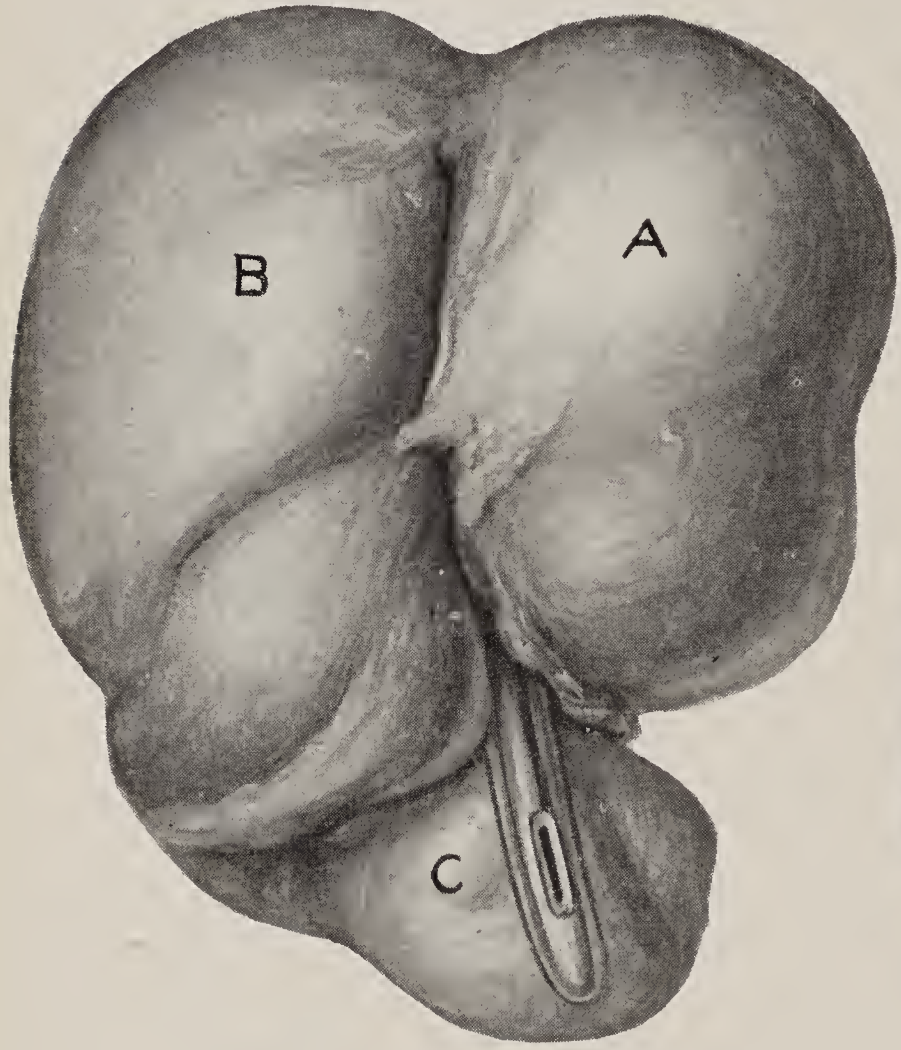

Fig. 389. Enucleated Prostate. Showing right, A, and left, B, lobes, and outgrowth, C, in the bladder growing from the left lobe. The catheter occupies the course of the urethra.

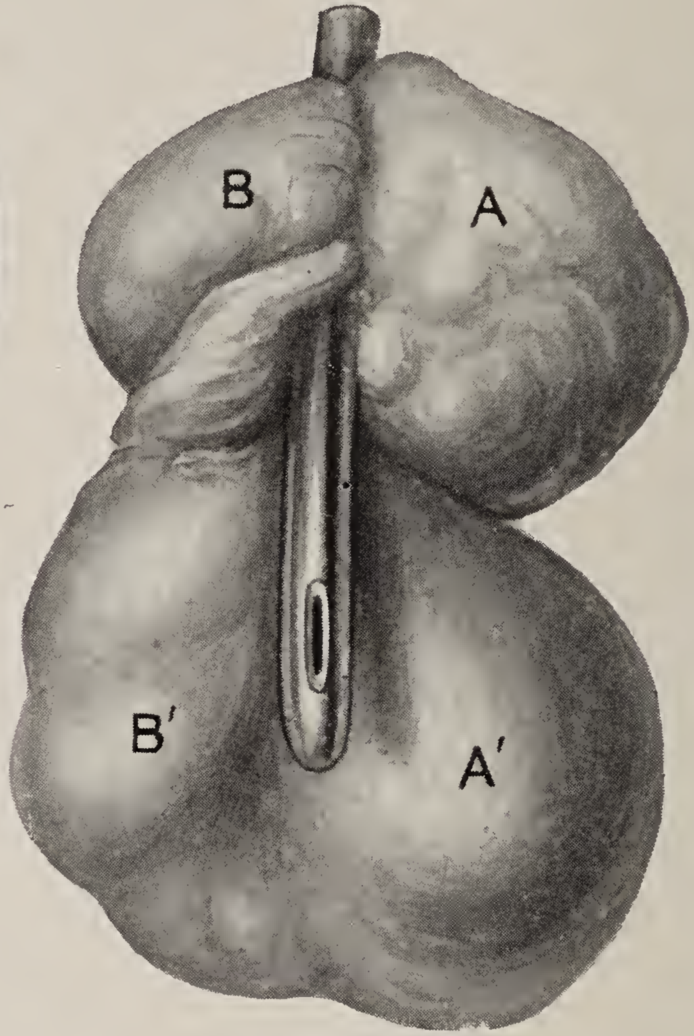

Fig. 390. Enucleated Prostate. Showing right, A, and left, B, lobes, and enormous outgrowth, A′, B′, in the bladder derived from both lobes.

I have latterly almost completely abandoned the attempt to preserve the urethra entire in the enucleation of the prostate. The excellent permanent results obtained from partial removal of the urethra with the organ have convinced me that no advantage is to be gained by leaving the vesical end of the urethra behind. In a large proportion of cases of enlarged prostate this vesical end of the urethra is extremely dilated, being trumpet-shaped, or distorted out of any shape resembling a more or less circular tube as in the normal prostatic urethra (see Fig. 389). Even when it is left behind, I have always had my doubts as to its ultimate fate in most instances. The probability is that, through want of support and adequate blood-supply, it sloughed in large part, and came away in the washings during the after-treatment.

Examination of specimens of prostate which, in removal, have opened along the anterior commissure (see Fig. 390)—to which category the great majority belong—will show that the dilated portion of the prostatic urethra, viz. that portion lying between the verumontanum and the vesical outlet, has come away with the prostate, the urethra in front of this being left behind. The portion of the urethra behind the point at which the ejaculatory ducts enter it is much more adherent to the prostate than that in front of it, between this point and the triangular ligament. In fact, in the greatly enlarged prostate this latter portion lies quite loosely attached to the lobes on either side. When a prostate is enucleated in its capsule from the sheath all round, and the lobes are gently separated from the triangular ligament by the point of the finger, the organ can be felt hanging on by the urethra and the ejaculatory ducts, and the finger-tip can be easily inserted on either side between the inferior portion of the prostatic lobe and the urethra. If now the finger-tip be placed behind the prostate in the median line above the ejaculatory ducts, and the prostate be propelled upwards into the bladder by the finger in the rectum, the urethra will be found to snap across at the verumontanum, leaving the ejaculatory ducts, as a rule, adherent to the portion of the prostatic urethra left behind.

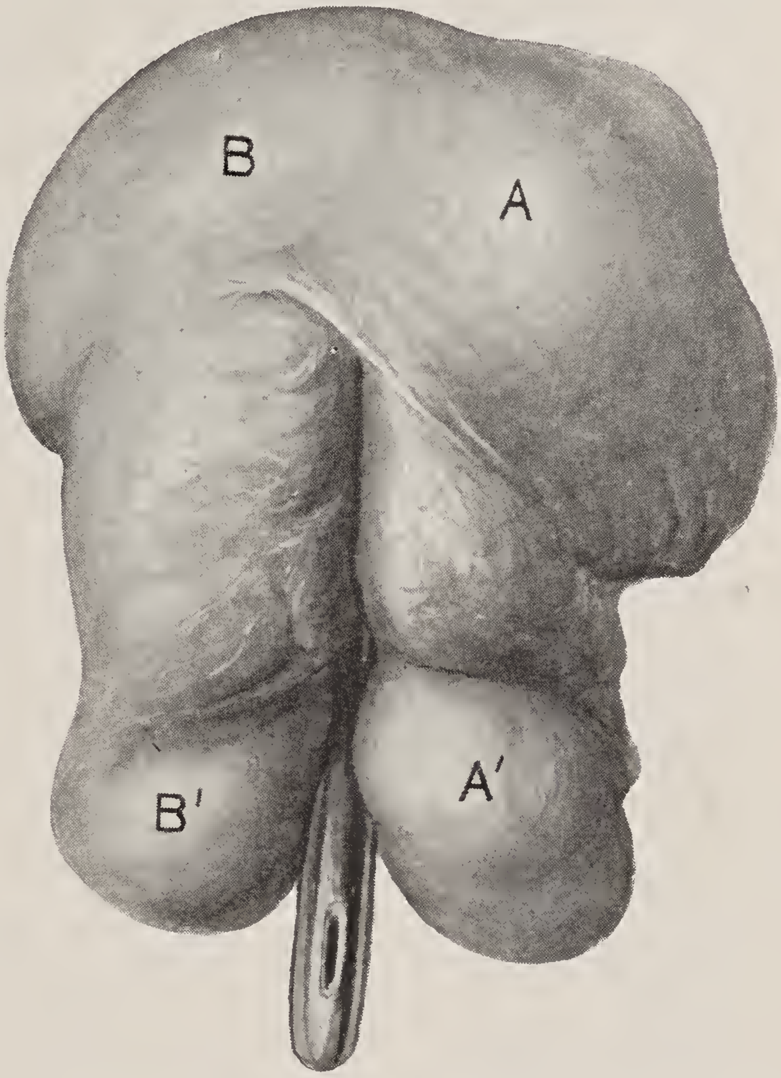

Fig. 391. Enucleated Prostate. Showing right, A, and left, B, lobes covered by a thin layer of the sheath, and outgrowths A′, B′, in the bladder from these lobes respectively.

Toilet of the wounds. With the delivery of the prostate from the bladder the essential part of the operation may be regarded as completed. The forefinger of one hand is reintroduced into the bladder forthwith, and that of the other hand into the rectum. The opposing surfaces of the cavity, from which the prostate has been enucleated, are then pressed together all round the vesical orifice between the tips of the fingers. By thoroughly kneading the opposed surfaces together in this manner the contraction of the cavity, and its diminution in size, are facilitated, and hæmorrhage is thus arrested, just as a dentist presses the gums together after the extraction of a tooth, or the accoucheur does the flaccid womb after parturition, with a similar object in view.

The bladder is then irrigated with hot boric lotion (temperature about 110° F.) through the catheter still *in situ,* for the purpose of removing clots, and, further, to control bleeding. This process should not, however, be continued for more than two or three minutes, as I find from experience that these irrigations not infrequently promote bleeding, instead of diminishing it, if the irrigation be continued too long.

The bladder having been cleared of clots, and whilst the irrigation is still proceeding, a stout india-rubber drainage tube is introduced through the suprapubic wound. The dimensions and management of this tube I regard as of the utmost importance in the after-treatment of this operation. I have been gradually increasing the calibre of this tube, till I now invariably employ ⅞-inch tubing, with a lumen of ⅝ inch in diameter. Two large perforations or eyes are made as near as possible to the vesical end of this tube (see Fig. 392), on opposite sides of it. Only about 1 inch of the tube should project into the bladder, just sufficient for the side openings to lie completely within its cavity. When the bladder is allowed to contract, the tube is gripped by it, so that the whole of the urine escapes through the tube. In this way infection of the loose tissues in the prevesical space is obviated and cellulitis prevented. On no account should the tube be inserted into the prostatic cavity, our object being to facilitate by every means the contraction of this cavity. If more than 1 inch of the tubing be introduced into the bladder, it will press on its base and give rise to constant straining, and pain in the end of the penis like that caused by vesical stone.

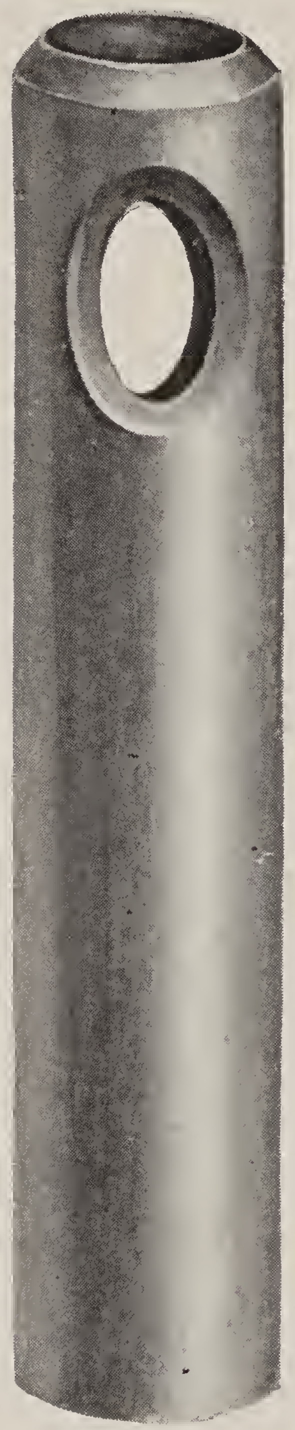
Fig. 392.
Prostatectomy Drainage Tube.
Actual size.

The edges of the parietal wound are now brought together around the tube by silkworm-gut sutures, one or two of which should pass deeply through the recti muscles. On no account should buried sutures be employed, as they are certain to be infected by the urine. One of the sutures should pass through the drainage tube to keep it securely in position. No sutures are inserted in the bladder.

Before withdrawing the catheter and applying the dressings the bladder is once more irrigated, in order to remove clots and ascertain that drainage is quite free. Finally, a couple of inches of broad iodoform-gauze tape are inserted in one angle of the wound against the side of the tube, and left there for twenty-four hours. This is done for the purpose of preventing the accumulation of fluids in the prevesical space. The wound is now covered with cyanide of zinc gauze, and the patient deeply swathed in absorbent dressings—front, sides, and back. The whole dressing is kept in place by a broad flannel binder or many-tailed bandage, loosely applied. Cotton-wool, wood-wool tissue, or cellulose may be employed. The last is most absorbent and keeps the patient driest; but a thin layer of cotton-wool should be placed between it and the skin; otherwise the cellulose, when wet, forms a pulp, which adheres to the skin and feels cold and clammy.

After-treatment. The dressings should be changed when saturated with urine, every four or six hours, according to the quantity of fluid secreted. During the first twenty-four hours after operation there will generally be some clots of blood lying in the drainage tube; these should be removed by long slender forceps at each dressing.

The bladder should be irrigated once daily by the surgeon himself, with warm boric lotion or a weak solution of permanganate of potash. For this purpose a long glass nozzle attached to the rubber tubing of an irrigating can is best, the nozzle being introduced through the drainage tube. During the first few days there should be very little pressure of fluid on the bladder, the irrigating can being held, or placed on a table, a little above the level of the patient's abdomen, so that the lotion flows into the bladder and out again through the drainage tube with very little force. It is all-important that in the early days the drainage should be thoroughly free, and that no pressure should be thrown on the cavity from which the prostate has been removed, either by the accumulation of urine in the bladder or by pressure from a high column of lotion, so that the cavity may remain at rest, and that blood-clot adherent to its surface may be undisturbed, thus obviating bleeding and facilitating the healing process. This is the main object with which I employ such a stout drainage tube—that the urine and clots may escape through it freely, and that, consequently, there may be no straining, which would have the effect of dilating the cavity. Patients who pass no urine *per* *urethram* for ten or twelve days after operation almost invariably do best.

The patient should lie on his back for twenty-four hours, after which he should be placed alternately on either side, and on his back. During the first four or five days he should not be allowed to make any exertion, all movements being effected by nurses. Should there be any oozing of blood after the operation, the foot of the bed should be raised on blocks and hypodermic injections of ergotin given. Shock, when it occurs immediately after operation, should be treated by warmth from hot-water bottles, extra clothing, hypodermic injections of strychnia, and enemata of coffee and brandy. Pain or spasms of the bladder should be relieved by hypodermic injections of morphia. Should there be any bronchial catarrh or other lung affection, the patient's head and shoulders should be well raised by pillows after the first twenty-four hours succeeding the operation. And in any case this position should be encouraged early, so as to obviate hypostatic congestion of the lungs.

As a rule, I remove the large tube four days after operation. If the patient be thin, the tube may be dispensed with in three days; if he be very stout, it should be left in for five days. By this time plastic lymph will have been thrown out round the tube, thus shutting off the prevesical space from contact with the urine and in this way avoiding the occurrence of cellulitis. Before removal of the large tube a smaller tube should be passed through its lumen and left in the fistula for a few days, to facilitate free drainage from the bladder, the wound in which may then be allowed to close as rapidly as nature can accomplish this by granulation.

The sutures are removed on the seventh or eighth day, by which time primary union will have taken place in the parietal wound, save, of course, in the track of the tube.

Irrigation of the bladder must be continued daily—twice daily, if the urine be at all foul—by inserting the long glass nozzle of the irrigator through the fistula right down into the viscus. The return stream will in the early days flow out beside the nozzle; but as the fistula contracts the nozzle will fill it; and the irrigation is then accomplished by alternately filling the bladder with the lotion and then withdrawing the nozzle, when the fluid will rush out with more or less force. As the case advances more and more pressure on the bladder may be employed. The irrigation should be continued till the boric lotion returns quite clear, or the permanganate lotion unaltered.

After nine or ten days from the operation Janet's method of irrigation may be employed, if possible. This consists in introducing the glass nozzle into the urethra and gradually raising the irrigating can till the column of fluid forces the lotion into the bladder and out through the suprapubic opening. This is, perhaps, the best method of flushing out the bladder, but some patients will not tolerate it, owing to the pain produced. It should never be employed during the first week after operation for fear of causing bleeding; and if it cause pain it should not be employed at all. Patients vary much in their tolerance of this method of irrigation.

After a fortnight or so, when the bladder is distended by lotion through the nozzle placed in the suprapubic opening, the patient will frequently pass the lotion *per urethram* as rapidly as it enters the bladder. When this takes place, it is an effectual method of flushing out the bladder.

It will be observed that I have not hitherto referred to the employment of the catheter for the purpose of washing out the bladder during the after-treatment. In the early days after the introduction of this operation I was in the habit of introducing a large-sized gum-elastic catheter through the urethra daily after the third or fourth day from the operation, and irrigating the bladder through this. The catheter was introduced partly in consequence of my apprehension that, if it were not thus employed, there might be contraction of the deep urethra during healing of the prostatic cavity. Experience has, however, taught me that my apprehension in this respect was quite unfounded, for in not a single instance has there been any contraction to interfere with the free flow of urine. I do not now introduce a catheter till the suprapubic fistula has contracted to such narrow dimensions that it will not admit the nozzle, so that irrigation cannot be practised in this way. It is employed only during the few days before the patient begins to pass urine *per urethram* in volume, in order to keep the bladder clean during this transition period. When once natural micturition is established, the bladder is, of course, automatically flushed out.

The management of the bowels is of the utmost importance. For three or four days previous to the operation the bowels should be freely moved once daily at least, by means of a laxative pill given at night and a mild saline in the morning. On the morning of the operation the lower bowel should be emptied by means of an enema. The bowels should then be left undisturbed for two or three days, when they should be freely moved by castor oil or liquorice powder, or any drug that can be depended on to act with certainty and efficiency. After this the bowels should be moved gently once a day by means of a pill taken at night or a saline in the morning, or both if necessary. Patients of the prostate age confined to bed are liable to the accumulation of fæces in the rectum forming a hard mass, owing to the want of tone in the bowel. The occurrence of this is attended by much discomfort and spasm of the bladder from pressure thereon, and this must be guarded against. Should its presence be suspected, a finger should be introduced into the rectum, the mass broken down, and removed by an enema.

Patients should, as a rule, be confined to their rooms, but not necessarily kept in bed, for three or four days before the operation. Poor, broken-down hospital patients will require to be kept under observation for several days at least, in order that they may be fed up, and their general health improved before operation.

I have entered somewhat at length into the details of the after-treatment, because I consider that an intelligent appreciation of, and attention to, them is not less essential to success than the skilful performance of the operation.

Secondary hæmorrhage. Secondary hæmorrhage has occurred in a few instances. It is a very rare sequela of the operation, but has to be dealt with occasionally.

Slight arterial hæmorrhage may occur from the suprapubic wound on removal of the large drainage tube on the fourth or fifth day. This is purely traumatic and due to the fact that the tube is gripped by the bladder. The utmost gentleness should be employed in removing the tube, which should be withdrawn slowly, and with a slight rotatory movement, should it be gripped very tightly by the wound. The bleeding from this cause is always trifling, and automatically ceases in a short time.

Should there be any obstruction to the free flow of the contents of the bladder through the tube during the early days after operation, the prostatic cavity is liable to be dilated, resulting possibly in venous hæmorrhage from its walls. This is controlled by readjusting the tube in such a manner that free outlet is given to the urine, and by irrigating the bladder through the tube with boric lotion as hot as the patient can bear.

But the most serious form of hæmorrhage takes place, strange to say, in the case of patients in whom the healing process is most rapid, resulting in the suprapubic wound closing earlier than usual. Urine is then passed *per urethram* before the prostatic wound is sufficiently healed to bear the resultant pressure on its surface, and hæmorrhage may take place owing to spasm of the bladder and the consequent undue pressure on the prostatic cavity. Should this occur, a full-sized rubber or gum-elastic catheter should be introduced through the urethra and tied in the bladder, so as to give free exit to its contents.

But should the hæmorrhage persist, giving rise to pain and spasm from the accumulation of clots in the bladder, no time should be lost in reopening the suprapubic wound, and in reinserting a large drainage tube for a few days, to relieve the pressure on the walls of the prostatic cavity. Hypodermic injections of ergotin and the administration by the mouth of calcium chloride should also be employed.

CHAPTER XVI

PERINEAL PROSTATECTOMY: OPENING A PROSTATIC ABSCESS

Concurrently with the introduction and development of suprapubic methods of removing the enlarged prostate numerous procedures have been devised for its excision by the perineal route.

DITTEL'S OPERATION

The earliest suggestion in this direction came, I believe, from van Dittel in the years 1880–90. His operation consisted in removing a wedge-shaped portion from the under surface of one or both lobes of the enlarged prostate with a view to relieve the pressure on the urethra. This was accomplished through an incision extending from the median raphé round the sphincter ani to the tip of the coccyx. The ischio-rectal fossa was opened up, and by dissection the rectum was separated from the prostate, which was exposed, and a wedge-shaped portion removed from one lobe. By extending the dissection in front a little beyond the middle line the other lobe could be exposed and similarly dealt with. An essential feature was that the bladder and urethra were left intact.

This operation does not appear to have been performed in many instances, and the records of cases were not very encouraging, fistulæ remaining in some of them owing to the urethra or bladder having been opened during the procedure, and imperfect results being obtained in others.

NICOLL'S OPERATION

Nicoll modified this operation by performing a preliminary suprapubic cystotomy. This was done for the purpose of introducing one or two fingers into the bladder with a view to pushing the prostatic tumour into the perineal wound, thus facilitating its removal, and at the same time obviating the opening of the mucous membrane of the bladder or urethra.

Alexander's operation. The procedure adopted by Alexander was somewhat similar to that of Nicoll, except that the urethra was opened on a staff and a perineal tube inserted for drainage of the bladder.

GOODFELLOW'S OPERATION

The patient being placed in the lithotomy position and a staff introduced, a median incision is made in the perineum from the base of the scrotum to the margin of the anus and carried down to the membranous urethra, which is entered by a lithotomy knife, and the opening extended to the neck of the bladder. The staff is then withdrawn and the finger introduced. With the tip of the finger the prostatic lobes are enucleated, commencing at the perineal aspect of the gland and working up towards the bladder, and removed through the perineal wound. The prostatic urethra is necessarily removed with the gland. No drainage tube is inserted, the urine being allowed to flow through the wound. Formerly Dr. Goodfellow passed a catheter through the wound every second day for a week or so to keep up free drainage, but latterly this practice has been abandoned, neither irrigation nor the passage of a catheter being permitted, and the cases are said to do as well as or even better than under the old practice.

PROUST'S OPERATION

In 1901 perineal prostatectomy received a marked impetus owing to the practical and lucid description of the operation given by Proust, of Paris, in the October issue of the *Presse Médicale,* subsequently elaborated in his work *Prostatectomie périnéale.* This operation, with modifications by various surgeons, was largely practised on the Continent in the years immediately following, and is so still in America, the most enthusiastic exponents being Albarran in France and Young in America. During the last three or four years, however, this operation has been undergoing a gradual displacement by the writer's operation of suprapubic enucleation, termed in France 'prostatectomie transvésicale.' Perineal prostatectomy has never been at all largely practised in England.

Proust's operation is as follows: The bladder having been washed out, a staff is introduced. The patient is then placed in the 'inverted perineal position.' By means of a metal framework attached to the operating table the patient's legs are held vertically and the thighs horizontally. The buttocks are raised on an inclined plane, so that the sacrum is almost vertical and the perineum directed upwards towards the ceiling of the room. The staff is held by an assistant so as to lift the urethra towards the pubic arch and thus avoid its being opened during the preliminary dissection of the perineum.

A concave incision, with its convexity forwards (see Fig. 393), is carried through the skin and subcutaneous tissues across the perineum to

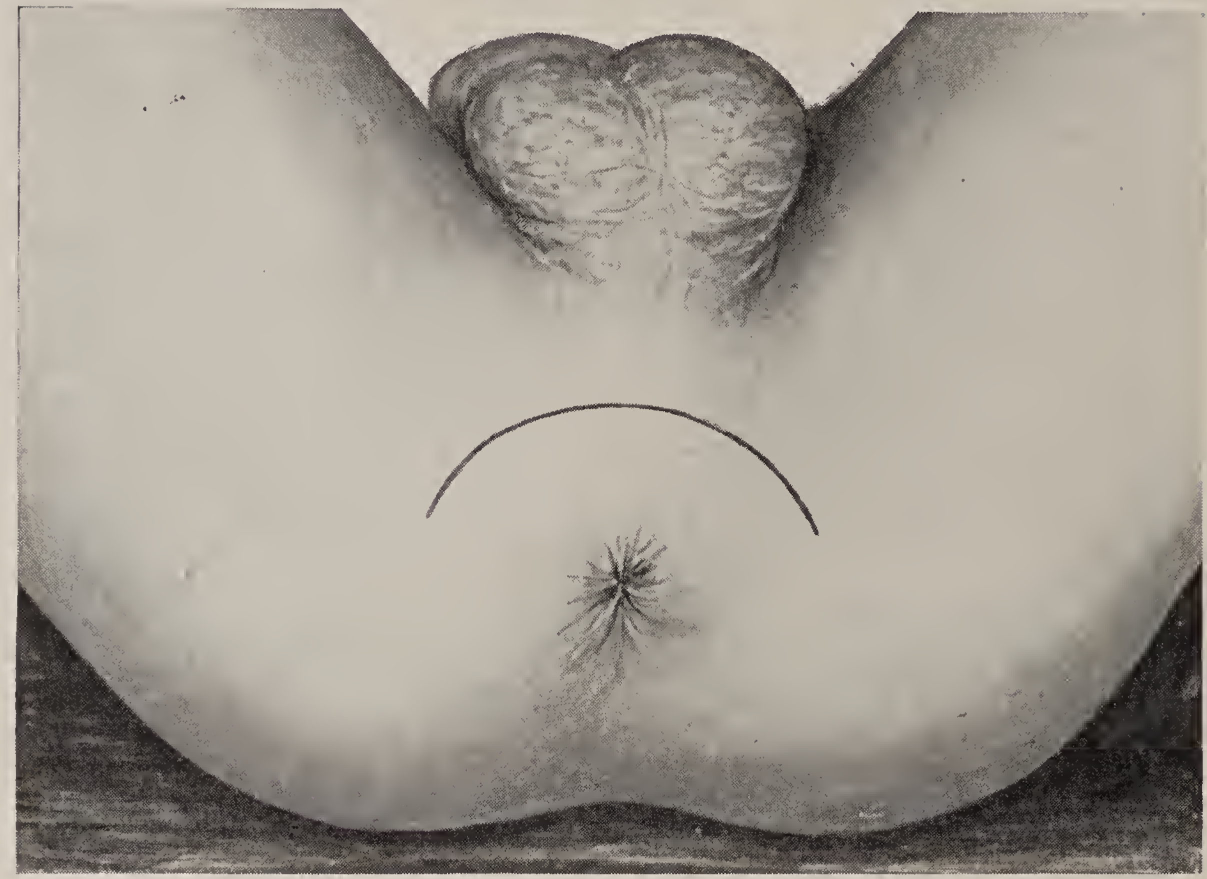

FIG. 393. THE SUPERFICIAL INCISION IN PERINEAL PROSTATECTOMY. (*Proust.*)

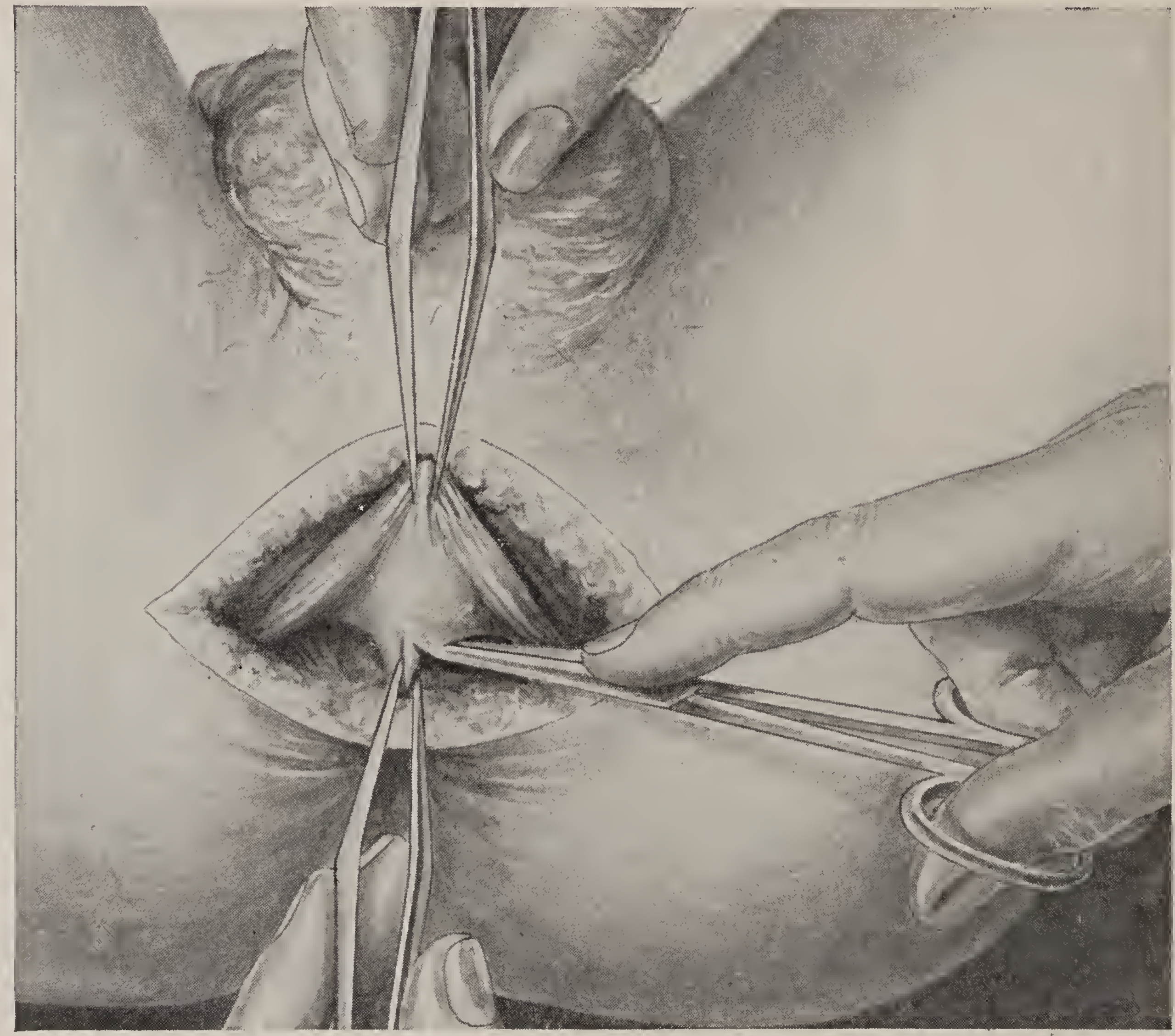

FIG. 394. SECTION OF THE RECTO-URETHRAL MUSCLES. (*Proust.*)

the ischium on either side, at a distance of two fingers' breadth from the anus. The external anal sphincter then comes into view behind, and the bulb, covered by the bulbo-cavernosus muscles, in front. The median fibro-muscular band uniting them (the ano-bulbar raphé) is then divided transversely. When the bulb is drawn forwards by forceps the posterior margins of the transverse perineal muscles are clearly defined.

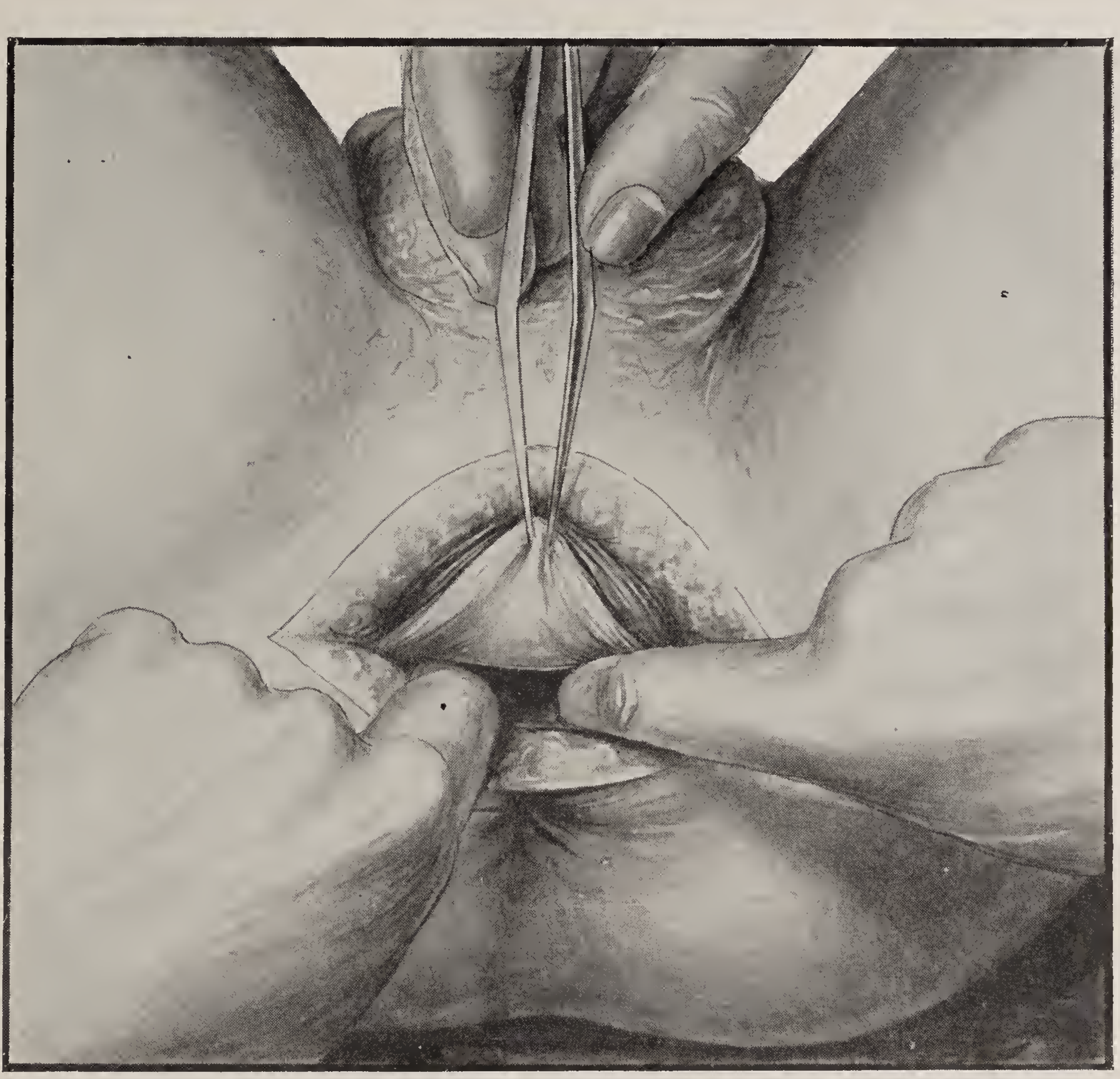

FIG. 395. THE TISSUES PUSHED ASIDE BY THE FOREFINGERS TO BRING THE PROSTATE INTO VIEW. (*Proust.*)

The bulb being still pulled forwards the posterior lip of the wound is drawn backwards, when the recto-urethral muscles, passing from behind forwards, come into view, and on either side the anterior margins of the levator ani muscle passing up behind the triangular ligament. Pushing the levatores ani aside by the fingers, the recto-urethral muscles, which draw the rectum forwards, are divided close to the transverse ligament (see Fig. 394).

The rectum then falls away backwards, and the apex of the prostate appears. Introducing the forefingers into the wound the tissues are pushed aside (see Fig. 395) and the smooth posterior aspect of the prostate, covered by its sheath, or outer capsule, is brought into view. If the various incisions have been properly carried out there will be scarcely any bleeding. A broad duck-bill retractor is now introduced in the posterior portion of the wound and the rectum is drawn forcibly backwards, when the prostate comes more fully into view.

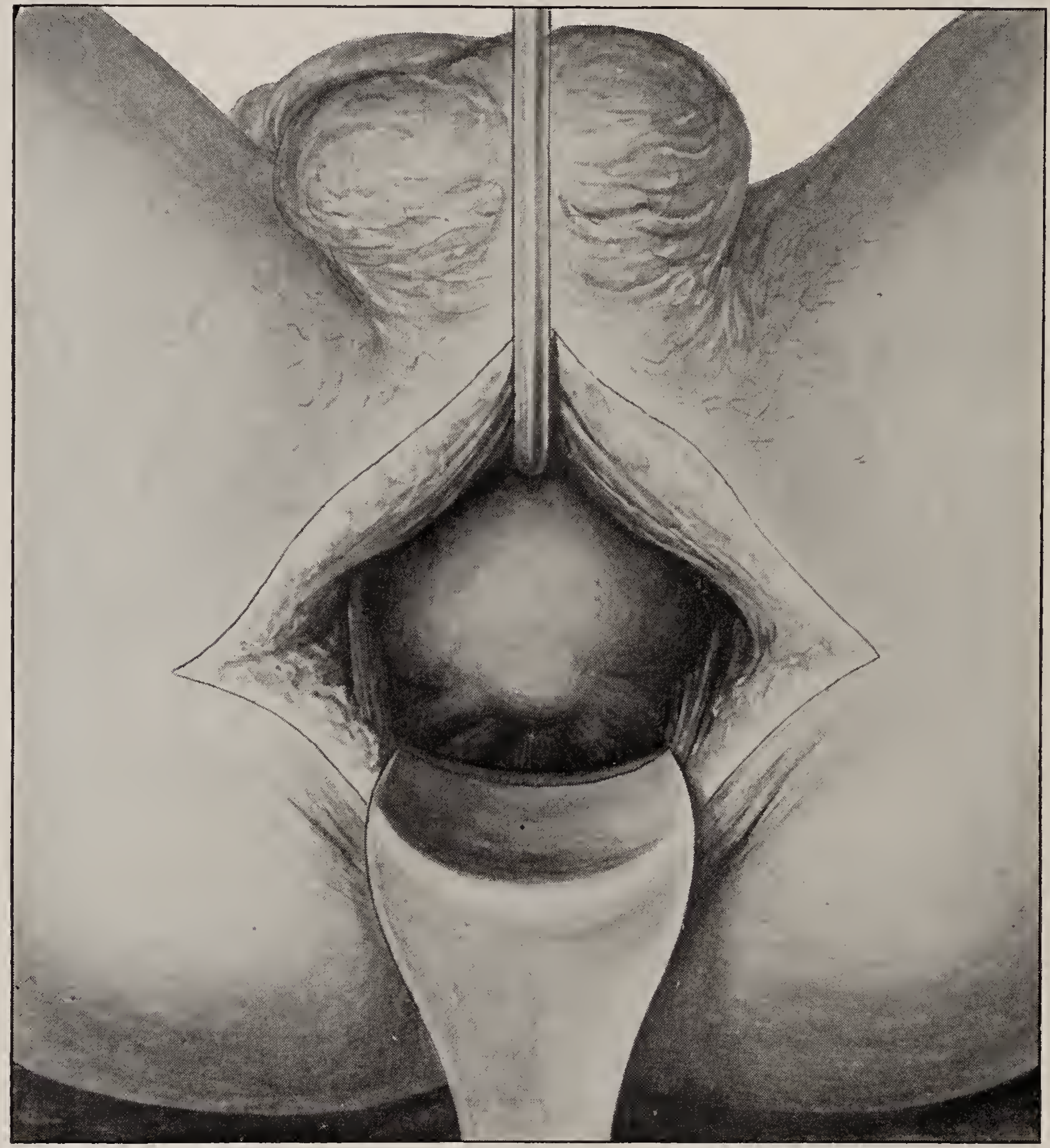

Fig. 396. Prostate made to protrude in the Wound by means of the Depressor. (*Proust.*)

The urethra is then opened on the staff at the apex of the prostate. Proust lays stress on opening the prostatic rather than the membranous urethra. The margins of the mucous membrane are caught by forceps or ligatures and drawn aside, and the 'depressor,' or 'tractor,' is introduced through the wound after the sound has been withdrawn. The arms of the depressor are opened and the neck of the bladder fixed by them. The instrument is then consigned to an assistant, who by this means pushes down the prostate and makes it protrude in the wound (see Fig. 396). Two strong catch-forceps are then applied to the sheath, one on either side of the urethra, and by means of scissors and a blunt dissector the sheath is peeled off the prostate (see Fig. 397).

The internal separation of the prostatic lobes from the urethra is then commenced. By enlarging the urethral opening backwards as far as the neck of the bladder, which, however, should not be incised, the prostate is bisected. The forefinger of the left hand is introduced through the wound as a guide, and each lobe is in turn separated from the urethra by scissors (see Fig. 398), a blunt dissector, and the forefinger of the right hand, a sufficient thickness of prostatic tissue being left to support the urethra. During the process of ablation of the lobes the tractor is used to depress them in turn into the wound, and strong catch-forceps are also brought into use to pull them to the surface.

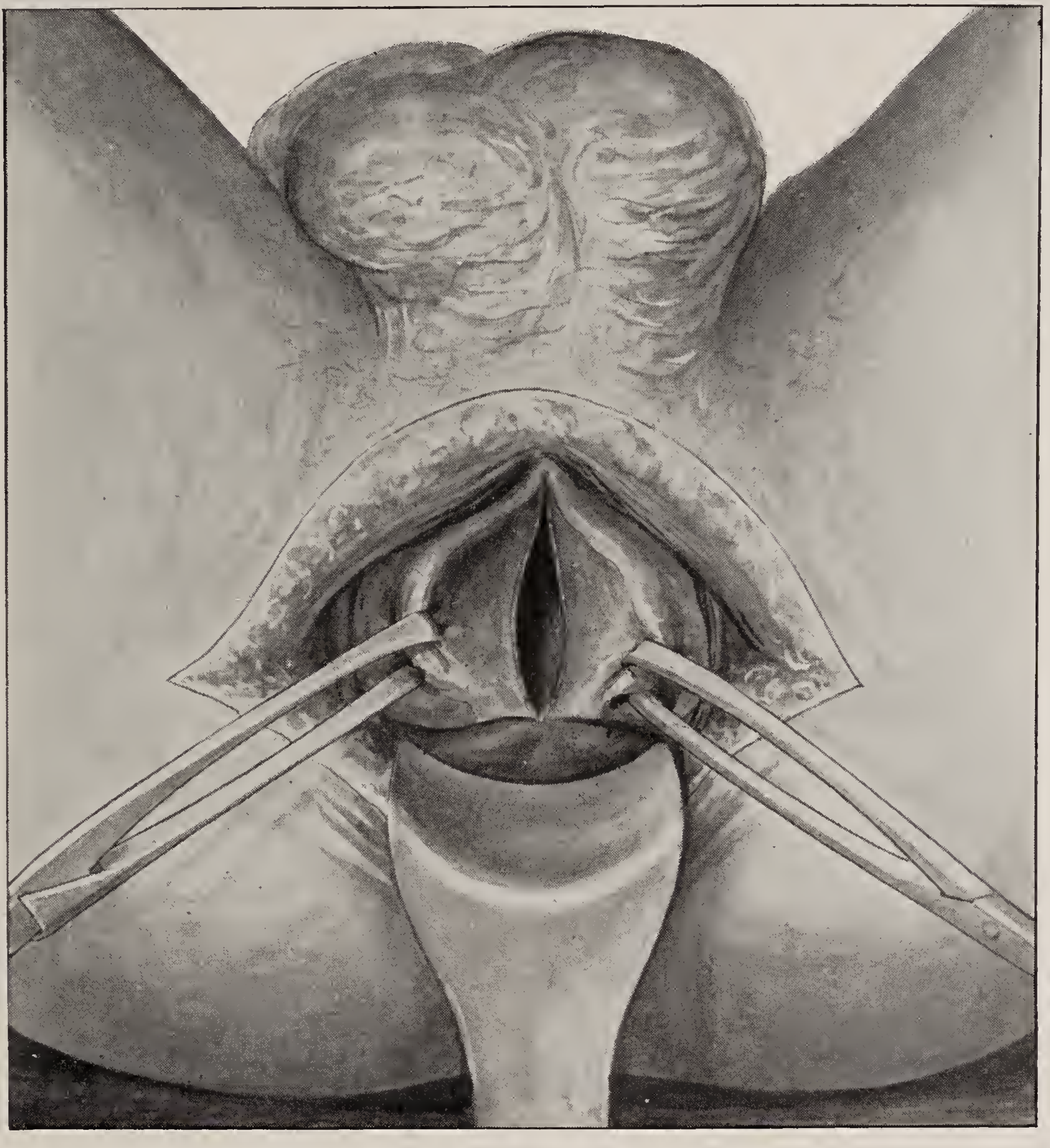

FIG. 397. BISECTION OF THE PROSTATE AND OPENING OF THE URETHRA. (*Proust.*)

Pediculated outgrowths of the prostate in the bladder are made to protrude through the urethral wound by hooking them down by the finger, when they are torn away or cut off by scissors. Broad-based masses are pushed by the finger, introduced into the bladder, into the wound on either side, and removed like the lateral lobes, care being taken that the mucous membrane of the bladder is left intact.

The exuberant portions of the urethra, which is, as a rule, greatly enlarged and distorted out of shape, are clipped off, sufficient membrane, however, being left to loosely cover a staff introduced through the urethra. The margins of the urethra are then brought together by several catgut sutures, commencing at the vesical extremity of the wound, sufficient room being left in front for the insertion of a drainage tube into the bladder on the withdrawal of the staff. A catheter is also introduced into the bladder through the penis and fixed in position, not for the purpose of carrying off the urine, which flows through the perineal tube, but for periodic irrigation of the bladder.

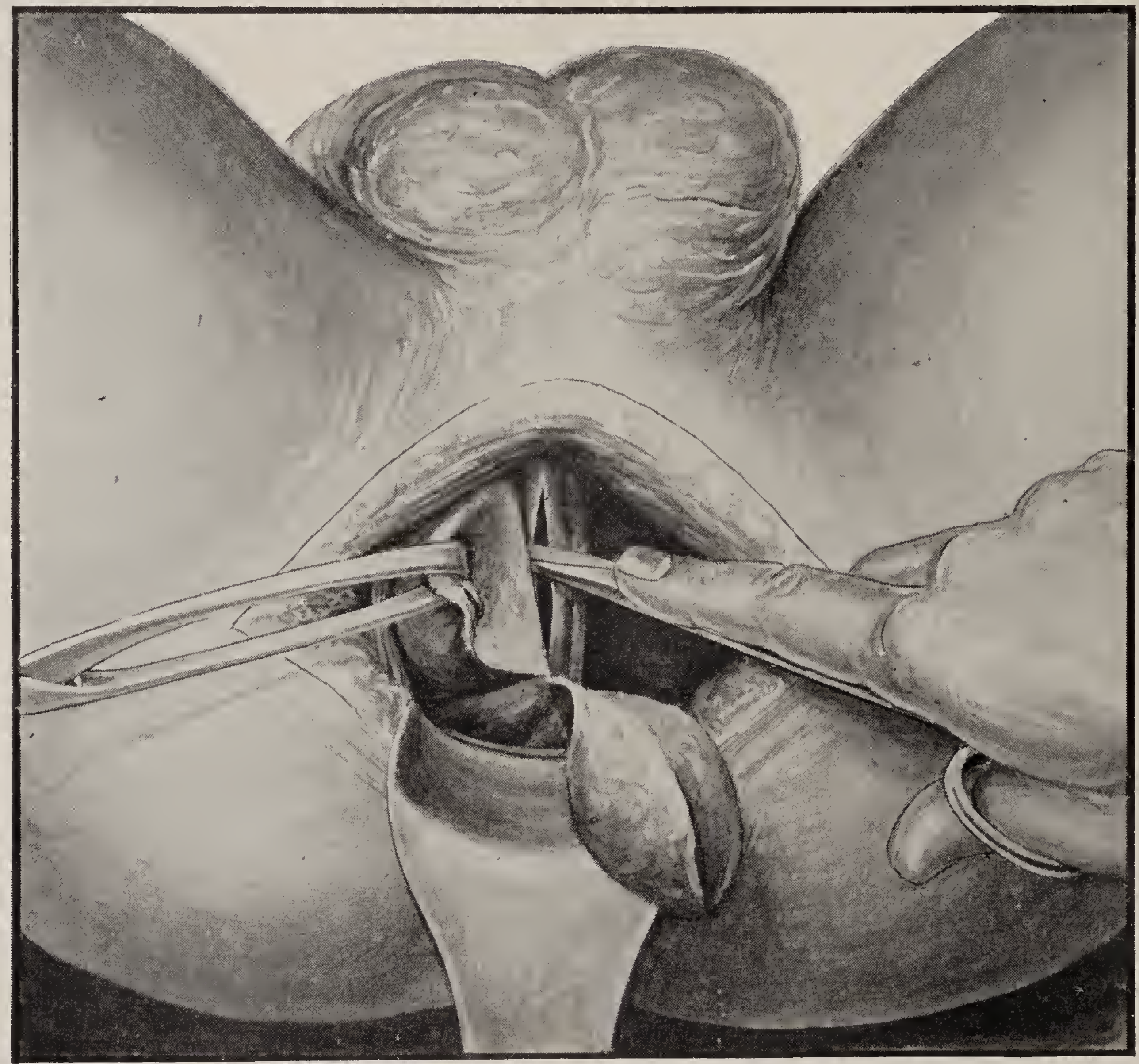

Fig. 398. Dissection of the Prostatic Lobes from the Urethra. (*Proust.*)

The levatores ani and adjacent structures are now brought together by one or two deep catgut sutures; strips of gauze for drainage purposes are placed in the perineal wound, and the posterior skin flap is brought forward and kept in position by sutures on either side, the central portion, through which the gauze strips protrude, being left open. Dressings are then applied and held in position by a broad T-bandage, pressure being mainly exerted between the coccyx and the anus, so as to bring the rectum in apposition with the bladder and urethra in the deep portions of the perineal wound.

The urine is conducted from the perineal tube to a pail beneath the bed by means of rubber tubing. The bladder is irrigated twice daily, and the dressings changed every day after the second. The perineal tube is removed after a week, but the catheter is left in, being changed from time to time as it requires cleansing or renewal, till the perineal wound is completely closed, during a period which is estimated at from three to five weeks, when the urine is allowed to pass naturally through the penis.

Albarran's modification. Albarran advocates the removal of the lobes *par morcellement* instead of each lobe being removed entire, and Proust admits that in some cases, particularly when the prostate is friable, this piecemeal ablation of the gland is necessary.

YOUNG'S OPERATION

Young follows mainly in the lines laid down by Proust, but introduces certain modifications in the procedure, the most important of which are these: (1) The preliminary perineal incision is in the form of an inverted V. (2) The membranous urethra is opened for the introduction of the 'tractor,' and, later on, the insertion of the drainage tube, an attempt being made to leave the prostatic urethra intact in the course of removing the prostate. (3) He endeavours to preserve the ejaculatory ducts intact, by leaving behind a central wedge of the prostate. For this purpose, after exposure of the posterior surface of the prostate, 'an incision is then made on each side of the median line for almost the entire length of the posterior surface of the prostate and about 1.5 cm. deep. The two lines are divergent, being about 1.8 cm. behind and 1.5 cm. apart in front. The

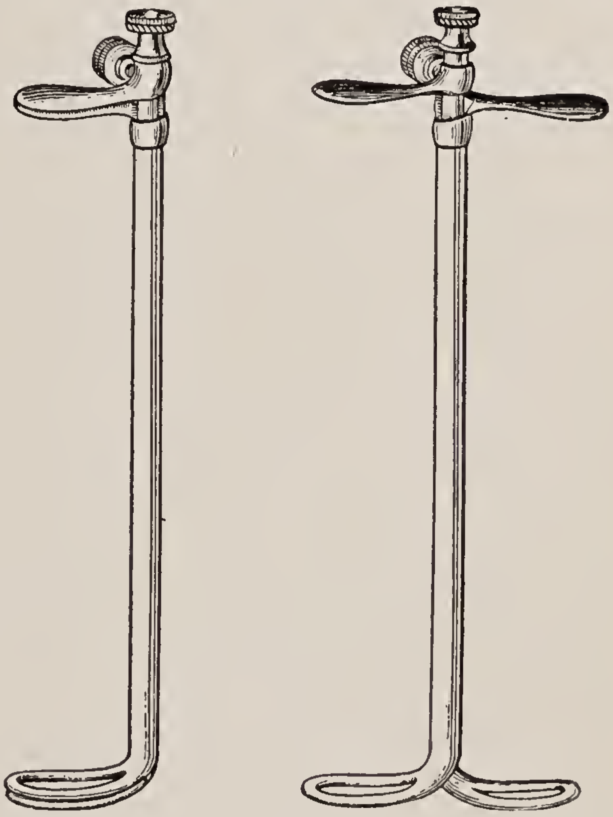

Fig. 399. Young's Prostatic Tractor or Depressor.

bridge of tissue which lies between them contains the ejaculatory ducts, and its preservation is of importance if the integrity of these non-obstructive structures is to be left uninjured. It is for this purpose that I make the initial capsular incisions 1.5 cm. deep on each side, and these define at once, and correctly, the width of the ejaculatory bridge, and prevent its being torn, as might happen if we depended on blunt dissection' (Young). (4) A double catheter is introduced into the bladder through the wound in the membranous urethra, for continuous irrigation, and fixed there by a suture. This is removed after twenty-four hours, and the urine allowed to flow through the perineal wound till it heals by granulation. (5) The lateral cavities are lightly packed with gauze, which is removed after twenty-four hours, and no further packing is introduced.

BOTTINI'S OPERATION

Division of the prostatic bar or outgrowth by means of the galvanic cautery was introduced by Bottini of Pavia. An electrode shaped somewhat like a Mercier's sound is introduced into the bladder through the urethra. The beak is turned round and the instrument is withdrawn till it impinges against the obstruction. The current is then turned on and the obstructing portion of tissue is burnt through.

This operation, though still practised in America and Germany, has never come into vogue in this country. It is applicable to only a very limited proportion of cases, in which the obstruction is confined to a median outgrowth, or prostatic bar extending across the floor of the orifice of the urethra. It is difficult, with one's present knowledge of the shapes and sizes assumed by the enlarged prostate, to understand how this operation can be of any permanent value. It is attended by considerable danger, as, being done in the dark, it is impossible to gauge accurately the extent of the destruction of tissue due to the cautery.

THE RESULTS OF PROSTATECTOMY

I have now completed 600 cases of the operation of total enucleation of the prosate for enlargement of that organ, the patients ranging from 48 to 89 years, with an average age of 68½ years, the prostates varying from ½ to 16¾ ounces, with an average weight of about 2½ ounces. The great majority of the patients have been entirely dependent on the catheter for periods up to 24 years. Nearly all were in broken health and many apparently dying before operation. Existence was simply unendurable to most of them. Few were free from one or more grave complications, such as cystitis, stone in the bladder, pyelitis, kidney disease, diabetes, heart disease, chronic bronchitis, paralysis, single, double and even treble hernia, and in some few instances there was malignant disease of some other organ than the prostate. Such were the unfavourable circumstances under which the operation was undertaken.

In connexion with these 600 operations there were 37 deaths in periods varying from 6 hours to 37 days after operation, or a mortality of 6.15%. The mortality has been steadily decreasing from 10% in the first 100 cases to 4% in the last.

The causes of death were: uræmic symptoms due to chronic kidney disease, 16; heart failure, 6; septicæmia, 2; shock, 3; exhaustion (kidneys were extremely diseased), 1; mania (hereditary in 1), 2; malignant disease of liver, 2; heat stroke, 1; pneumonia, 1; acute bronchitis, 1; pulmonary embolism, 1; and cerebral hæmorrhage with paralysis, 1.

Though all these deaths are accepted in connexion with the operation, in not more than one-half the number can the fatal result be attributed thereto, the remaining deaths being due to diseases incident to old age and unconnected with the operation.

In 108 cases vesical calculi were removed at the same time, but all the deaths in these cases are accepted in connexion with the prostatectomy operation, none being put down to the suprapubic lithotomy involved.

The mortality from perineal prostatectomy is constantly stated to be less than that from suprapubic enucleation of the gland. This may have been the case in the early history of the operations, say from 1900–5; but I do not think that this has been the case in recent years, when the latter operation has been performed on the lines laid down in my writings.

No real comparison can, however, be instituted between the mortalities attending the two operations, for the simple reason that, as the records of cases show, the types of patients dealt with are not similar,—the ages being more advanced (I have operated upon 47 octogenarians between 80 and 89 years, and 9 aged 79 years), the prostates much larger, and, as a rule, the general conditions of the patients more unsatisfactory in cases submitted to suprapubic enucleation than in those operated upon by perineal prostatectomy.

The success attending suprapubic enucleation means an absolute cure, the patient regaining the power of retaining and passing urine naturally without the aid of a catheter as well as he ever did. There is no relapse of the symptoms, no contraction at the seat of operation leading to stricture, and no fistula remains. Further, there is no diminution in the sexual power.

Can perineal prostatectomy be said to be followed by similar good results? Though I have no personal experience of this operation on modern lines, my observations on patients operated upon by others, the printed records of cases, and conversations I have had with many Continental and American surgeons lead me to answer emphatically in the negative. The success attending perineal prostatectomy in a large proportion of the cases is not a cure at all, but at most an amelioration of the pre-existing conditions, and frequently not even that. Perineal prostatectomy is frequently followed by recto-vesical, recto-perineal, and uro-perineal fistula; incontinence of urine, temporary as a rule, but sometimes permanent; frequency of micturition, due to residual urine; stricture requiring the frequent introduction of sounds; and complete loss of sexual power—a very grave drawback when dealing with men sometimes scarcely beyond the prime of life.

Perineal prostatectomy is, indeed, not a complete prostatectomy at all; and one of the gravest dangers of leaving a portion of the gland behind (designedly in Young's operation) is the liability of adenomatously enlarged prostates to degenerate into cancer as life advances, a liability which such an able surgeon and keen observer as Pouchet of Amiens puts down at 10%.

EVACUATION OF A PROSTATIC ABSCESS

A prostatic abscess should be opened at the earliest moment after its presence has been definitely diagnosed, for it may rapidly increase in size, destroying one or both lobes of the organ, and burst into the urethra, the rectum, or the ischio-rectal fossa.

Operation. The perineum having been shaved and purified, the patient is anæsthetized and placed in the lithotomy position. The forefinger of the left hand is introduced into the rectum, its palmar surface being directed forwards and its tip resting on the prostate at the point where fluctuation is most distinct. The point of a long stout scalpel is then introduced in the median raphé of the perineum 1 inch in front of the anus, and pushed onwards in the direction of the tip of the finger placed in the rectum, and then, as it is withdrawn, the external incision is enlarged. Sinus forceps are then passed through the wound as far as the abscess and the jaws opened. When pus begins to flow, the forceps being withdrawn, the forefinger of the left hand, previously purified, is passed through the wound, the opening into the abscess is enlarged and all septa are broken down. A stout drainage tube is then introduced into the depth of the abscess cavity, which is thoroughly irrigated with an antiseptic lotion. The tube is fixed in position by a suture in the perineal skin.

Sometimes there is rather profuse bleeding, requiring the cavity to be packed with iodoform gauze round the drainage tube, which in these circumstances should be made of gum-elastic tissue.

If the urethra be opened during the manipulations, it is advisable to pass a perineal drainage tube into the bladder and allow the urine to flow clear of the wound for a few days. The urinary fistula thus formed will soon close as granulation of the wound proceeds.

THE PROSTATE GLAND

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THE PROSTATE GLAND

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INTRODUCTION

The prostate gland, the most important of the male accessory reproductive glands, has, until recent times, remained something of a mystery. By the earliest anatomists it was regarded as a urinary organ; and even after its identification as a part of the generative system, its anatomy, histology, and function were but imperfectly understood, and its pathological manifestations remained a vexatious problem to students of urology almost up to our own time. Indeed, even now many of these controversial points are still unsettled and capable of stirring up a considerable amount of acrimonious partizanship when brought up for discussion — a sure proof that there is still much to be learned about this diminutive but highly important part of the male organism.

When the author first entered upon the study of prostatic anatomy and physiology, about 1908, a review of the existing literature revealed an amazing divergence of opinion, especially in the department of embryology — the chief bone of contention being the integral relationship of the " median lobe " to the rest of the structures about the vesical orifice.

EMBRYOLOGY

1. THE PROSTATE GLAND

Earlier embryological concepts. A " third lobe " of the prostate gland was described by Sir Everard Home in 1806, and this view was accepted by most British anatomists until the work of Sir Henry Thompson, many years later, cast doubts upon the accuracy of Home's investigations.

Griffiths, investigating the literature published before 1889, found the entire subject of prostatic anatomy " in a very unsatisfactory state," some anatomists claiming that the median lobe is an independent structure which does not invariably occur, while others maintained that not only is the median lobe a constant part of the gland, but it is formed by an ingrowth from the lateral lobes. After extended examination of the evidence obtainable, Griffiths concluded that: (1) A third, or median, lobe does exist, and may be observed as well defined in subjects who have arrived at puberty, and in later adult life previous to the age at which clinicians have come to expect prostatic enlargement. The occurrence of this lobe is not invariable, however, as in a certain proportion of specimens examined it was small or entirely absent. (2) This third lobe, when it exists, is equipped with ducts whose orifices communicate with the posterior wall of the prostatic urethra, that is, the portion of the duct which extends from the verumontanum to the orifice of the bladder. (3) Embryologically, this lobe has a distinct development unconnected with that of the urethra. This separate development takes place in exactly the same way as that of the lateral lobes, which have no embryological connection with the section of the urethra on either side of the verumontanum adjacent to which they lie. The median lobe is *not* the result of a backward extension of glandular tissue from the lateral lobes which comes to occupy the space beneath the vesical neck and between the vasa deferentia, as maintained by previous anatomical investigators.

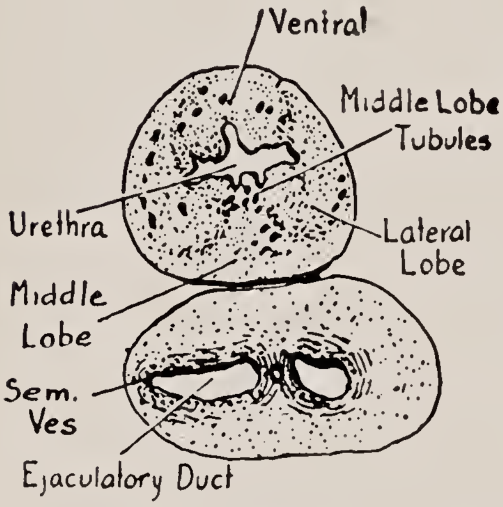

FIG. 1. Human fetus, 7.5 cm. length (3 months). X 20. Showing the first development of prostatic tubules. (Courtesy of American Journal of Anatomy.)

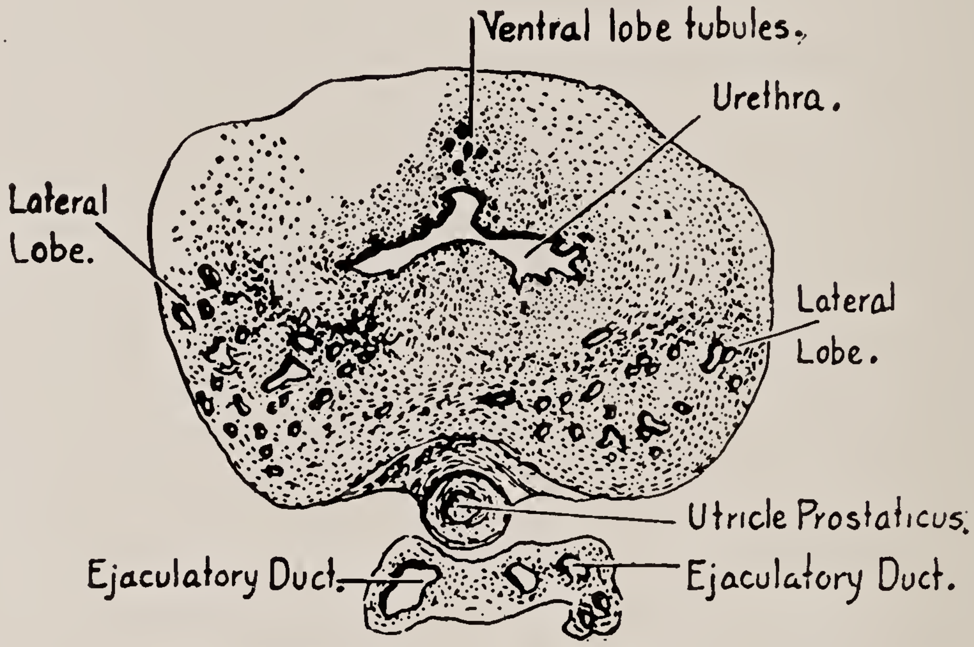

FIG. 2. Human fetus, 19 cm. (5½ months). This specimen has no independent median lobe. In this particular case, tubules from the lateral lobes grow into the region usually occupied by the median lobe. (Courtesy of American Journal of Anatomy.)

This position was questioned, four years later, by Jores, who asserted that the median lobe is only an isthmus of glandular tissue the function of which is to connect the lateral lobes, and that it is not, therefore, an independent structure.

Shortly after, Moullin reasserted the existence of the median lobe as a separate entity, and pointed out that while, embryologically, the prostate gland is an outgrowth from the stalk of the allantois and, to a certain extent, from the cloaca (its origin thus being the same as that of the urethra), numerous substantiated physiological facts refute its association with the urinary tract and establish its identity as a sexual organ. Though the first portion of the urethra is independent of both the müllerian and the wolffian ducts — from which the generative organs take their origin — the fact that the prostatic ducts have their orifices there, instead of from the lining of the wolffian ducts, is due simply to displacement of these orifices, in exactly the same way that the ureters develop. (The ureters at first are prolonged from and open into the wolffian ducts; but during the gradual alterations attendant upon embryological development, their orifices shift so that eventually they come to open into the bladder.) In Moullin's opinion, the presence or absence of a median prostatic lobe in a given individual depends upon the extent to which this displacement has occurred. If the glands find openings only in the prostatic sinus, no formation of the median lobe will take place; but if, in the course of embryological growth, a certain proportion of them are removed to an area nearer the bladder, they may either occupy the median line, or, remaining on the posterior urethral wall, come to form a more or less distinct median lobe. In rare instances these glands may appear on the anterior wall as well.

Soon after the appearance of Moullin's article, Keibel came forward to dispute his contention that the prostate has no part in the urinary function — arguing, from the fact that this gland is formed from tubules arising beyond the wolffian and müllerian ducts, that it belongs among the urinary organs and cannot be considered a part of the generative system.

Five years later appeared Pallin's elaborate consideration of prostatic embryology, in which he postulated the origin of the prostate as a separation of the outer side of the urethra's epithelial wall into solid longitudinal folds. This separation occurs about the third month of fetal life, and by it three groups of prostatic tissue come into existence: (1) a cranial group, from the wolffian and müllerian ducts (genital cord), in the dorsal direction; (2) a caudal group, also from the wolffian and müllerian ducts, and lying in the dorsal direction; and (3) a ventral group. The first and second groups develop from the prostatic sinus — the cranial developing to form the main base of the prostate, and the caudal the lateral and posterior portions of the lateral lobes. The third lobe does not appear to arise from independent glands, but, rather, from ramifications of the glands of the first group (cranial), which can extend as far as the midline and there develop into gland parts. The third (ventral) group originally fills most of the anterior urethral wall; but by the fourth month the number of glands composing it is considerably diminished so that it appears in the median line as an anterior lobe, or its reduction may be so great as to amount practically to atrophy. Pallin's work was carried out with true Teutonic thoroughness, and was beautifully illustrated by wax models of three-months' and four-months' embryos. It received very serious consideration in scientific anatomical circles, and its author's pronouncements were widely accepted as final.

In 1908, however, Evatt, a British investigator, making use of the wax-model method, pointed out that Pallin did not seem to have observed three ducts which he found arising from the internal wall of each prostatic sinus, at a point just below that of the entrance of the genital cord. The lowest of these ducts was horizontal, and they all passed directly backward, branching frequently, and were remarkable in that they were the only ducts seen in his model which did not pass upward. It was plain to Evatt that these horizontal ducts, including the large ducts from the bottom of the sinus, were not originally separated as longitudinal folds. The branches of the two largest ducts, he found, came together in the midline behind and, together with two smaller ones lying immediately above them, coalesced at about the point where the genital cord entered and thus formed a *third lobe* which, being composed of ducts originating on both sides of the prostate, could not reasonably be regarded as an unpaired structure.

In Tandler and Zuckerkandl's classic monograph upon prostatic hypertrophy, published in 1912, Griffiths' view regarding the embryological development is, for the most part, accepted for these authors maintain that, morphologically and developmentally, the median lobe is an independent structure. They claim, however, that it is *always* present.

The foregoing summarizes the chief contentions for and against the existence of the median lobe as an anatomical entity, as well as the various theories accounting for its origin and development. There is a consensus of opinion that the median lobe has its origin from ingrowth of the lateral lobes.

Regarding the number of tubules in all sections of the prostate which convey secretion to the urethra, the usual text-book estimate is from 20 to 30. Greater variation of opinion exists in regard to the proportion which the glandular tissue bears to the interglandular stroma — the estimates running from the five-sixths of Thomson-Walker to the one-third or one-half of Nakasima. There is also considerable difference of opinion in regard to the stage of fetal development at which the prostate emerges as an identifiable structure. Mihalkovics believed it could not be identified before the fifth month; Kölliker placed its appearance at the fourth month; the more recent writers incline to the opinion that development begins in the third month or shortly thereafter. According to Pallin, the muscular structure is in evidence by the fourth month, but Mihalkovics and also Tourneux state that smooth muscle does not appear before the middle of the fifth month.

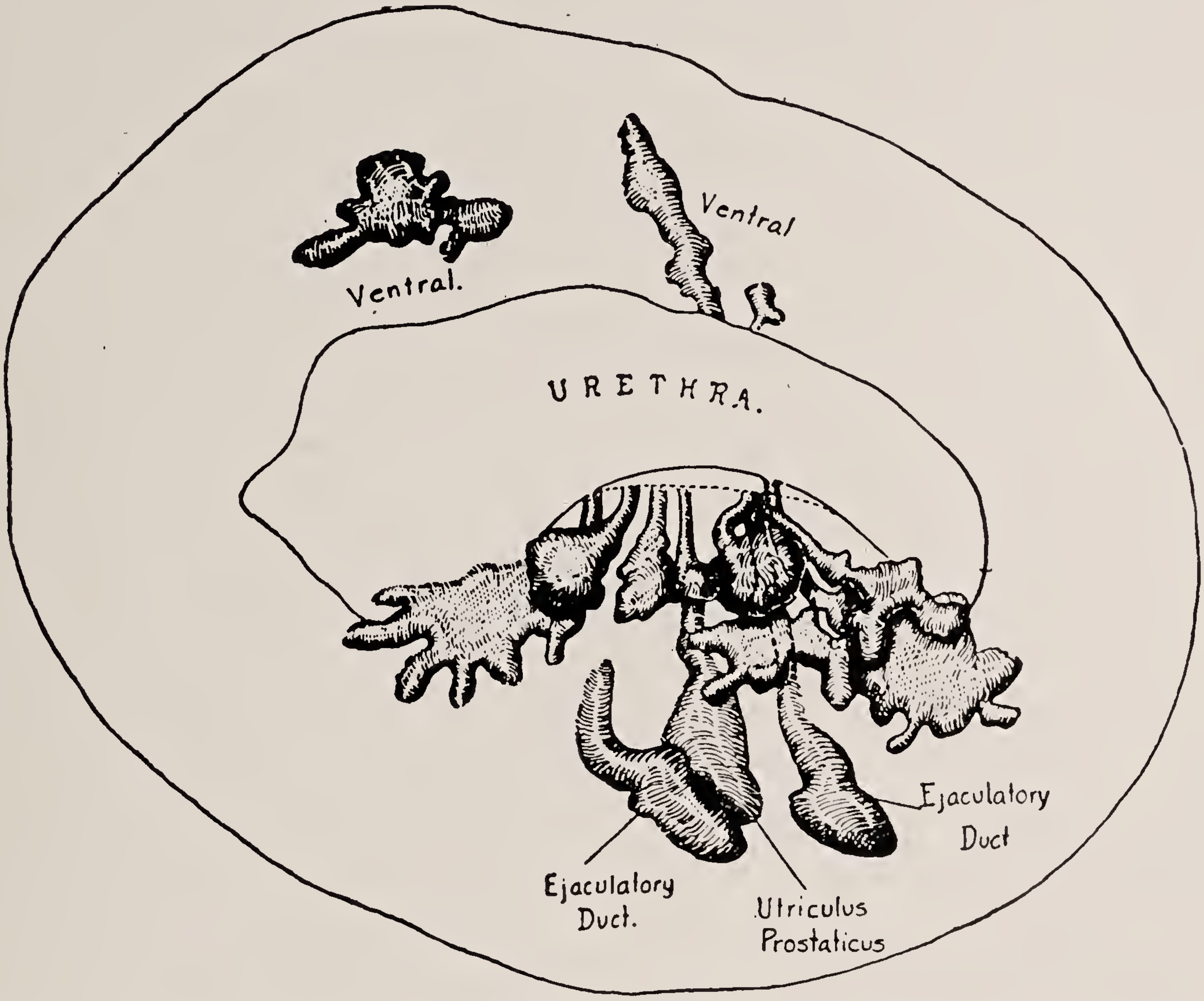

FIG. 3. Human fetus, 12.5 cm. (4 months). X 30. Composite drawing showing course of the median-lobe tubules. (Courtesy of American Journal of Anatomy.)

Present embryological views. Investigations into the embryonic development of the prostate gland were carried out by the author upon specimens varying in age from 10 weeks to full term; and the study was further visualized by the construction of a wax model of the human prostate gland as it appears at birth.

There is no evidence of the development of the prostate gland until the third month of fetal life. At this time, solid epithelial outgrowths make their appearance from 5 distinct parts of the embryonic prostatic urethra. These solid masses are made up of cells which stain deeply and early assume a circular arrangement, forming lumina and branches and thus producing the tubules which constitute the prostatic nucleus. From these 5 points of origin there therefore arise 5 groups of tubules: the first lying on the urethral floor, between the vesical neck and the orifices of the ejaculatory ducts and prostatic utricle; the second and third, on either side of the urethra in the prostatic furrow; the fourth, just below the point where the ejaculatory ducts and utricle open into the urethra, upon the urethral floor; and the fifth, in the prostatic urethra, upon the ventral, or anterior, wall. By the development of these tubules and their enclosure in stroma there eventually arise 5 lobes, namely the median, right and left lateral, posterior, and anterior lobes. Early in fetal life there is wide separation between the median lobe and the lateral lobes, but in the later stages this distance is greatly diminished. None of the specimens examined showed any actual intermingling of the tubules, but after birth the median and lateral lobes lay side by side, with no definite capsule separating them. The posterior lobe, however, was entirely distinct, a dense layer of fibrous tissue separating it from the lateral lobes; and the anterior lobe was at a considerable distance from the lateral lobes, separation being quite complete.

The youngest fetus examined showed no sign of muscular fibers about the prostatic tubules; but by the sixteenth week a slight differentiation in staining properties was noted, and by the twenty-second week there was considerable development of the muscle layers, especially at a point where certain of the lateral-lobe tubules extend away from the base of the prostate. The muscle structure progressively increased in thickness as older specimens were examined until, at birth, a dense-layered muscular structure was seen to surround some of the tubules.

The Median Lobe. As one of the specimens examined in the course of this study showed no evidence of tubules in the usual location of the median lobe, the investigation was extended to adult and autopsy specimens in order to determine the relative frequency of absence of the median-lobe tubules. In all, 103 specimens were examined, and among these there was but one — the fetus just mentioned — in which there was undoubted absence of glandular tissue in the median-lobe region, although in 5 (3 of which were seen at the Pathological Museum of Guy's Hospital, in London) it was impossible to determine whether or not glandular tissue was present.

In all the other fetal specimens examined, the median lobe was seen to develop independently from the group of tubules lying on the floor of the urethra, between the bladder and the orifices of the ejaculatory ducts. In the younger specimens, the median-lobe tubules were separated from the tubules giving rise to the lateral lobes by a considerable area of tissue containing no glandular elements; but as older specimens were examined, this intervening area gradually decreased until, in the later fetal stages, although the tubules and their branches did not lose their characteristic position, there was no longer a distinguishing fibrous capsule separating the median from the lateral lobes.

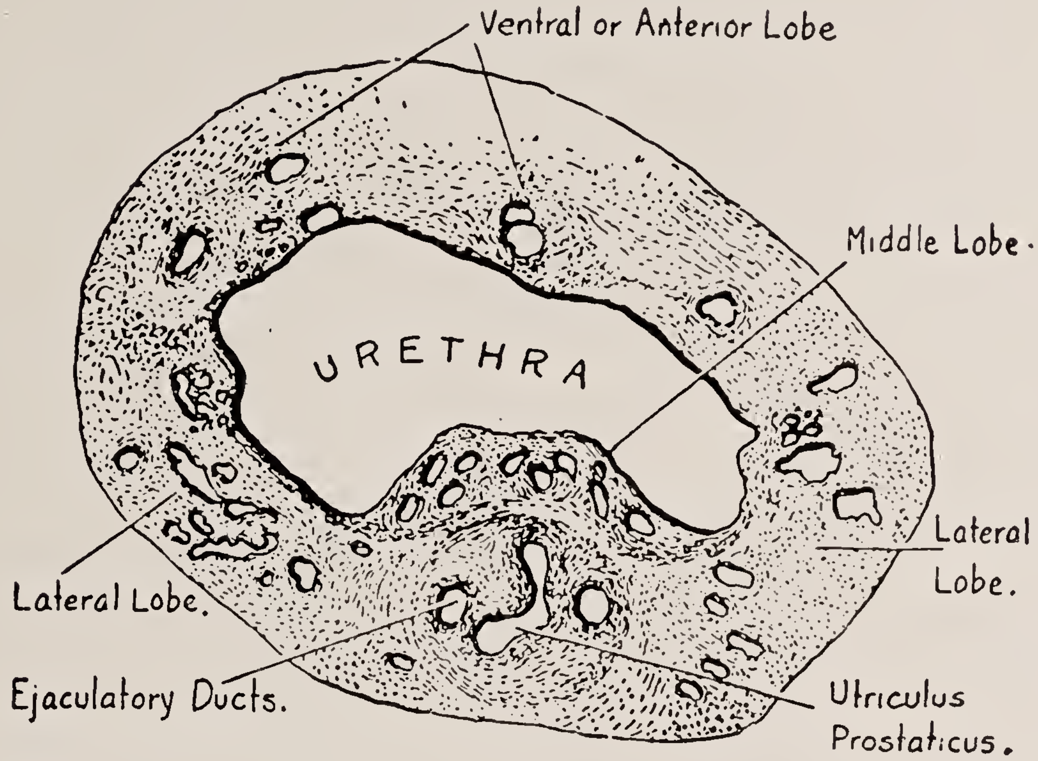

FIG. 4. Human fetus, 12.5 cm. (4 months). Showing rather definite separation of the median lobe from the lateral lobes. (Courtesy of American Journal of Anatomy.)

As the structures of the verumontanum develop, the ducts of the largest median-lobe tubules, which originally lie close to the midline, are displaced so that they open high up on the sides of the verumontanum, their original position in the midline being occupied by the orifices of the ejaculatory ducts and prostatic utricle.

The average number of tubules in the median lobe was, in this study, found to be 10.

The Lateral Lobes. The lateral lobes are composed of tubules both larger and more numerous than those of the other lobes. They originate on the lower part of the lateral walls of the urethra from the right and left prostatic furrows, and, by backward and outward extension, form the major part of the prostate's base. Although there is always a certain degree of separation between these lobes, this is much greater in early fetal life. The nearer the full term of gestation is approached, the less definite this separation becomes, except at the point where the ducts communicate with the urethra, where the distinction always remains perceptible. The lateral-lobe tubules always grow backward toward the bladder except in the apical region, where a few send branches in a forward direction. In the specimen examined by the author, where there was absence of the median lobe, branches from the lateral lobes extended into the region normally occupied by the median lobe.

In a specimen from a newborn infant, the lateral lobes displayed two tubules which branched widely and formed practically a glandular commissure by extending up into the region of the anterior commissure. Usually the lateral lobes show a considerable extent of stroma between their anterior portions, anterior-lobe tubules being present in this stroma. A definite plane of connective tissue separates the posterior branches of the lateral-lobe tubules from the posterior prostatic lobe, and mesially the ejaculatory ducts, urethra, and median lobe intervene.

In the specimens examined, the average number of tubules in the two lateral lobes was 37.

The Posterior Lobe. The posterior lobe is an independent structure, developing from tubules which are distinct from those of the other lobes, and separated from them by a capsule that is only connected laterally with the capsule enclosing the entire prostate. In every specimen examined, the posterior lobe was found to be present. Its tubules make their initial appearance in the third month of fetal development, together with those of the other lobes. They are found on the urethral floor, below the orifices of the ejaculatory ducts and prostatic utricle, and their direction of growth is backward toward the bladder and behind the ejaculatory ducts. They form the major portion of the prostate's apex, the part of the gland which is palpable through the rectum. While they are relatively large and have numerous branches, they are few in number — the average in 6 specimens being only 8. Their branches, like those of the tubules of the anterior portion of the lateral lobes, extend forward into the apical region. Although no evidence of such stroma is perceptible in the early months of fetal development, later the posterior lobe is separated from the ejaculatory ducts and the posterior sections of the lateral lobes by a layer of connective tissue devoid of tubules.

The posterior lobe is of especial interest to surgeons, for it has been established that primary prostatic carcinoma begins here in over 75 per cent. of cases. On the other hand, benign hypertrophy practically never takes place in the posterior lobe. When we add to these findings the further knowledge gained by embryological investigation — namely that the tubules comprising this lobe are entirely independent of and, in the fully developed adult, much larger than, the tubules forming the remaining lobes — it appears likely that the function of the posterior lobe may be distinct and different from that of the remainder of the gland.

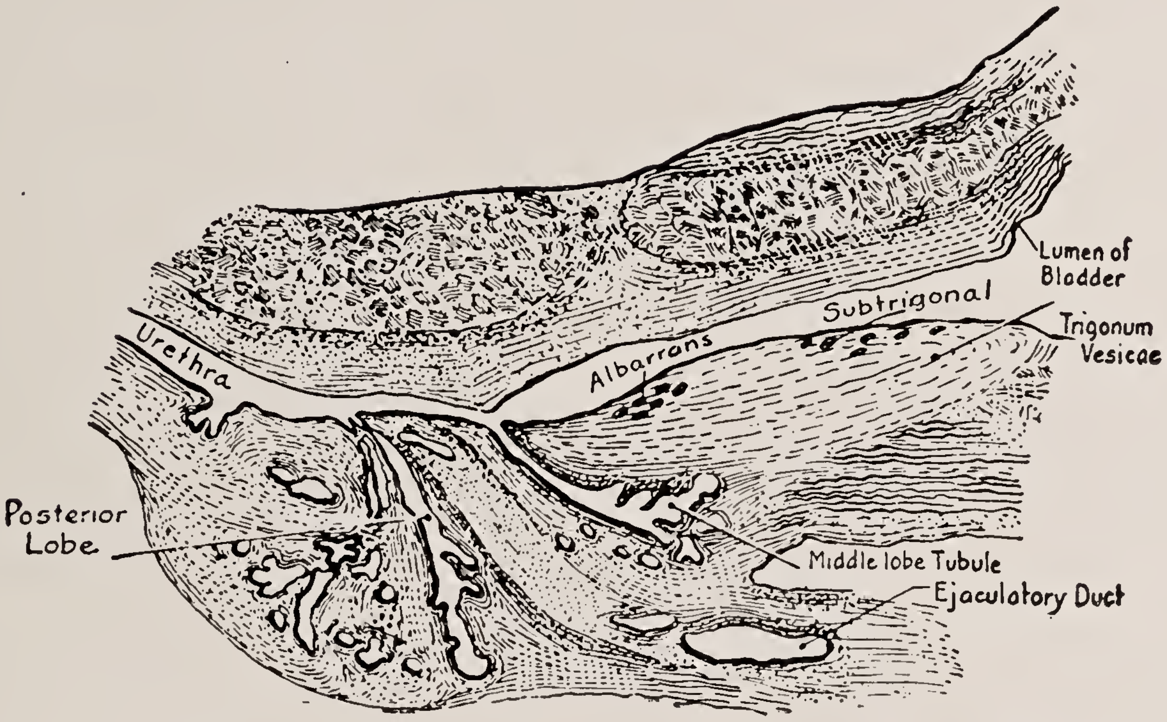

Fig. 5. Human fetus, 16 cm. X 15. Sagittal view of prostate gland showing relation of the posterior-lobe and median-lobe tubules to the other structures of this region. (Courtesy of American Journal of Anatomy.)

The Anterior Lobe. The anterior, or ventral, lobe begins to develop at the same time as the other lobes, being formed from large, multi-branched tubules which originate from the anterior wall of the prostatic urethra. The size of these tubules, however, does not remain relatively so large, for by the sixteenth week they are even somewhat smaller than the tubules of the other lobes, and by the twenty-second week they have decreased still further in size, as well as in number, and appear to have lost most of their branches. Thereafter, the anterior lobe becomes increasingly insignificant until, at birth, only two small tubules are in evidence. Occasionally, however, the anterior lobe persists into adult life for among the 593 adult prostates which were examined in connection with this study, there were found 10 with hypertrophied anterior lobes, one of which showed carcinomatous degeneration. Kuznitsky reported finding a persistent anterior lobe in one out of every 15 adult prostates examined by him.

The average number of anterior-lobe tubules in the fetal specimens examined was 13 for the first half of the intrauterine period, and 6 for the second half.

Prostatic-duct Openings into the Urethra. One of the most significant findings of this investigation was that relating to the number of prostatic ducts opening upon the floor of the prostatic urethra. In most text-books the number is given as from 20 to 30 — an estimate that appears to be far below the actual average. In none of the specimens examined by the author were there fewer than 53 ducts opening into the prostatic urethra; 2 specimens showed as many as 74; and the average for 6 specimens — one of which had no middle lobe — was 63. Although nearly three decades have passed since the results of this investigation were first published, there has never been any refutation of these figures, so far as the author knows, although many text-books — even in their revised editions — still continue to make the original estimate.

2. STRUCTURES ADJACENT TO THE PROSTATE GLAND

Introduction. A great deal of attention has been paid by anatomists to the embryology of the various structures adjacent to the prostate gland and so closely allied to it that a certain amount of consideration of their interrelationship — embryologically and physiologically — is inevitable in any analysis of prostatic anatomy. Most important of these structures are the seminal vesicles and ejaculatory ducts, the internal sphincter, and the vesical trigone.

Seminal vesicles, ejaculatory ducts, and prostatic utricle. The seminal vesicles begin to develop about the third month of fetal life, according to McMurrich, although Pallin found no indication of smooth muscle in the ejaculatory ducts as late as the sixth month. Watson, a later investigator, found that the seminal vesicles make their initial appearance during the thirteenth week of intrauterine life. They are at first merely lateral evaginations, or out-pocketings, from the lower part of the wolffian ducts; but by the fourteenth week, evaginations upon the walls appear and 3 distinct sacculations may be seen at a given level in each vesicle. By the nineteenth week, sacculation of the ampullæ begins, each vesicle showing from 3 to 8 distinct sacculations at a given level. By the twenty-first week, dilatation of the ducts to form ampullæ has advanced to about the condition found at birth; and by the twenty-fifth week, the vesicles and ampullæ have assumed practically their adult form in respect to general outline and sacculation. In the thirtieth week, the vesicles will be found lying beneath the middle part of the vesical trigone — their ampullæ uniting, deep in the base of the prostate gland, with the vasa deferentia to form

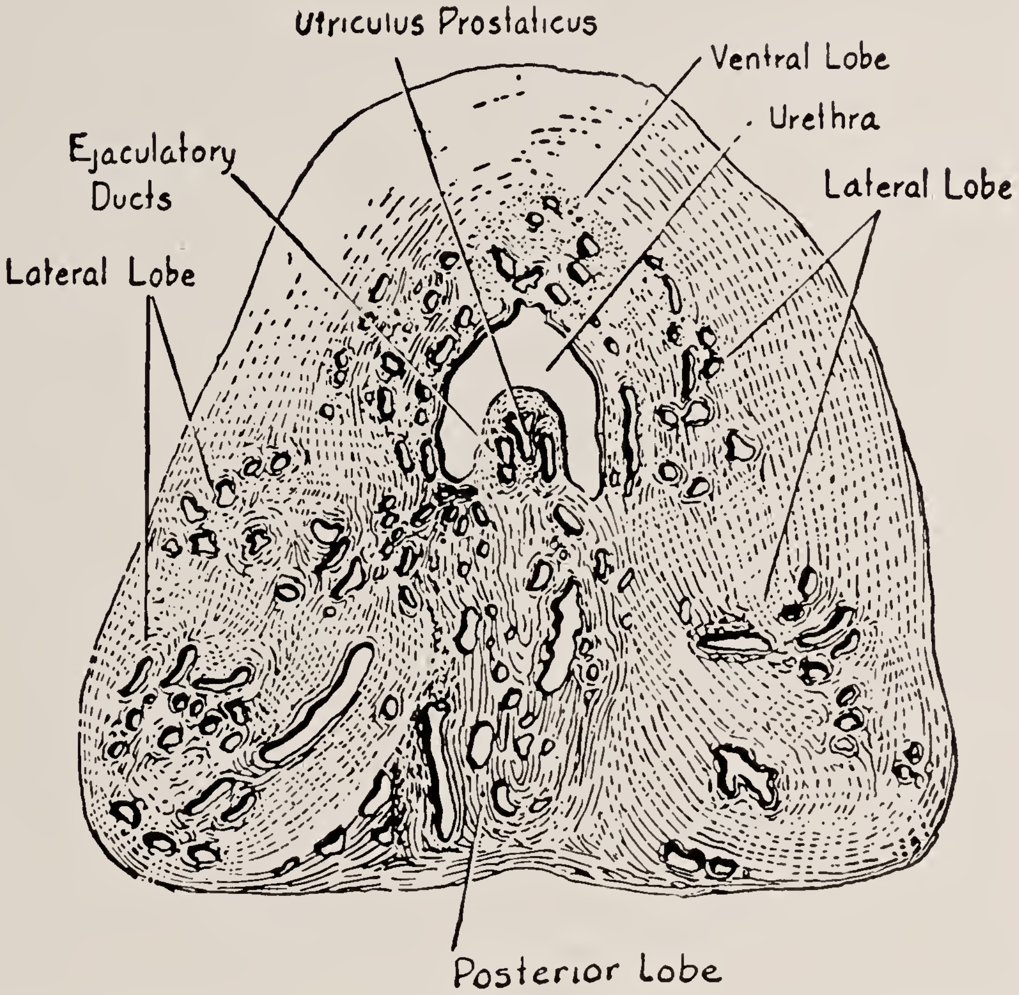

FIG. 6. Human fetus, 27 cm. (7½ months). X 14. The posterior-lobe tubules are widely separated from the lateral-lobe tubules by a definite lamella of connective tissue. The ejaculatory ducts and prostatic utricle are seen in the verumontanum. (Courtesy of American Journal of Anatomy.)

the ejaculatory ducts. At birth, the ends of the vesicles extend back almost as far as the base of the trigone.

The ejaculatory ducts open into the posterior urethra to the right and left of the prostatic utricle (uterus masculinus) on the anterior surface of the verumontanum (colliculus seminalis). According to Watson, the opening of the prostatic utricle into the posterior urethra takes place between the twenty-first and twenty-fifth weeks of fetal life, although the lumen is still bifid, indicating the union of two partially fused tubes — the counterparts of the müllerian ducts of the female. D. Berry Hart considered the colliculus seminalis in the human male to be analogous to the hymen and lower third of the vagina in the female because, in the adult male, the müllerian ducts are not represented by anything except the hydatids of Morgagni and, possibly, some rudimentary remains near the testicles. The view expressed by Primrose a year or two earlier is very similar to this, as he looked upon the prostatic utricle as the embryological homologue of the parts of the female generative tract which result from fusion of the müllerian ducts (namely, the uterus and vagina). It is the belief of Minot that the müllerian ducts never advance beyond the rudimentary stage in the male, the so-called hydatids of Morgagni being formed by the abortion of their middle portions, leaving only the upper, fimbriated ends. By the union of their caudal ends within the genital cord there is formed the prostatic utricle, which may, therefore, be rightly regarded as the rudimentary complement to the uterus and vagina of the female.

Subcervical (Albarran's) group of tubules. In 1902, Albarran made public his important observations in regard to a group of glandular tubules lying beneath the vesical neck, their ducts situated between the muscle layer and the mucous membrane. These subcervical tubules, or, as they are frequently called, "glands of Albarran," were noted to be extremely variable as to size and number in individuals otherwise apparently normal, in some cases being wholly lacking. They begin to develop about the fourth month of fetal life, and during the remainder of the gestation period gradually increase in size and number. The number present at birth usually remains the same until the period of puberty, at which time the tubules again begin to multiply.

Internal vesical sphincter and vesical trigone. In the course of the author's investigations of prostatic embryology, observations were also made on the fetal development of the bladder.

The study was begun with a fetus 5 cm. in length (estimated age, 10 weeks). At this stage of development, the bladder is a cylindrical tube made up of embryonal connective tissue and joined near its base by the ureters. These two ducts pass through the wall of the cylindrical bladder, their tissue fibers extending so as to be superimposed upon the bladder wall, thus forming the trigonum vesicæ. No tissue which in any way resembles muscle is to be detected; nor can one distinguish the area which later will be occupied by the vesical sphincter, except that alteration in the size and shape of the lumen is observable.

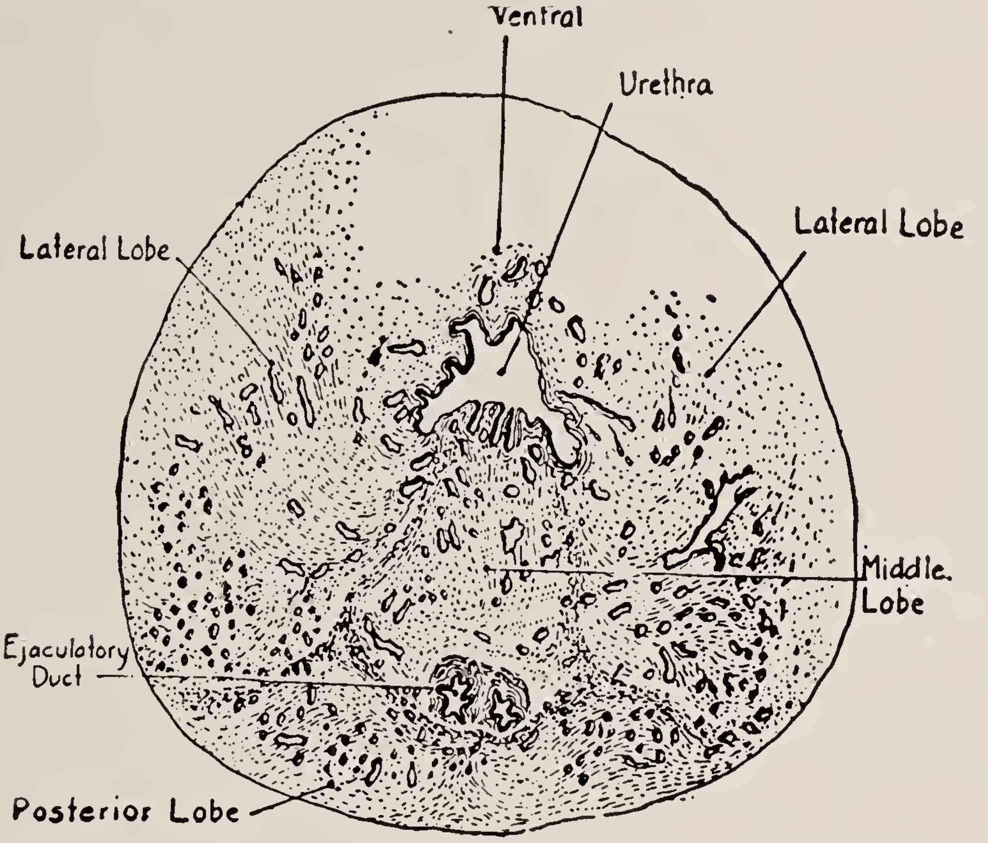

FIG. 7. Prostate gland at birth; 36 cm. body length. X 6, camera lucida. All five lobes of the prostate are here beautifully shown. It is important to the surgeon to note the close adherence of the ejaculatory ducts to the fibrous partition separating the posterior lobe from the other portions of the gland.

In a fetus 13 weeks old, however, this muscular development has been initiated, for circular interlacing of the fibers has commenced — longitudinal strands of tissue, which take on a deeper pink color than that assumed by most of the connective tissue of the bladder wall, being in evidence. The bladder base has thickened until it is deeper than any other portion of the circumference; and the wall beneath the trigonal area, with the superimposed trigonum vesicæ, has a depth five times that of the anterior wall. The trigone's muscle fibers can now be traced from between the ureters down upon the remainder of the trigone, and it is noticeable that their texture is much finer than that of the fibers of the bladder wall proper. An abrupt narrowing in the circumference of the lumen indicates the position of the future vesical sphincter; and a few fibers, circularly arranged, are at this time observable.

In a fetus 16 weeks old, the difference between muscle and connective tissue fibers is clearly defined; the fibers forming the trigone can easily be traced from their place of emergence from the ureteral walls out into the trigone; and the mucosa is smooth and closely adherent to the trigone, although elsewhere it is arranged in folds. The constricted opening of the bladder neck is sharply outlined by encircling muscular fibers. By the twentieth week, there is an enormous increase in the size and number of the fibers forming the vesical sphincter. By the twenty-second week, the relation between the size of the trigone and the underlying bladder wall and that of the remainder of the wall has undergone a change, for this part of the wall has enlarged less rapidly than other sections. The fibers of the trigone are more closely bound together than those of the rest of the bladder; the mucosa covers it smoothly; and the sphincter, although large, is in very close relationship to the rest of the vesical musculature. The development of the bladder musculature goes steadily forward as growth continues, the base being always the thickest part. At birth, the sphincter is very thick in its posterior quadrant, with its greatest dimension at the upper margin. Many of the muscle fibers, instead of encircling the orifice, mingle with the longitudinal fibers which originate on the anterior surface of the bladder. The fibers at the outermost portion of the sphincter are not now so numerous, but those visible entirely encircle the orifice.

Extensive investigations of the internal sphincter were made, in 1907, by Versari, who arrived at the following conclusions: (1) The smooth muscle sphincter of the urinary bladder, in the male, is an entirely distinct structure, which develops separately from either the circular muscle coat of the bladder or the urethra, or from the musculature of the urethra. (2) This muscle has both a urethral and a trigonal portion; only one portion — the urethral — can assume a circular form about the urethral orifice of the bladder. A bundle arrangement of the first group of sphincter fibers is observable, these corresponding to the anterior arch of the urethral portion; those of the posterior arch of the urethral portion are arranged immediately behind them, the last of these being apparently the trigonal portion. The posterior arch eventually comes to have a far greater extent than the anterior one because, by the continual addition of new bundles of fibers, it extends either upward into the trigonal area, or downward in the region of the posterior urethral wall.

The more recent studies of Wesson followed the development of the internal sphincter through a considerable series of embryos, using glass-plate reconstructions and macerated specimens. According to his findings, the fibers of the external longitudinal layer of the bladder sweep down along the surface of the bladder, converging, as they approach the vesical orifice, into fairly narrow bands on both the anterior and posterior surfaces. Most of the fibers of the posterior band pass forward between the bladder mucosa and the prostate gland, where they diverge slightly to

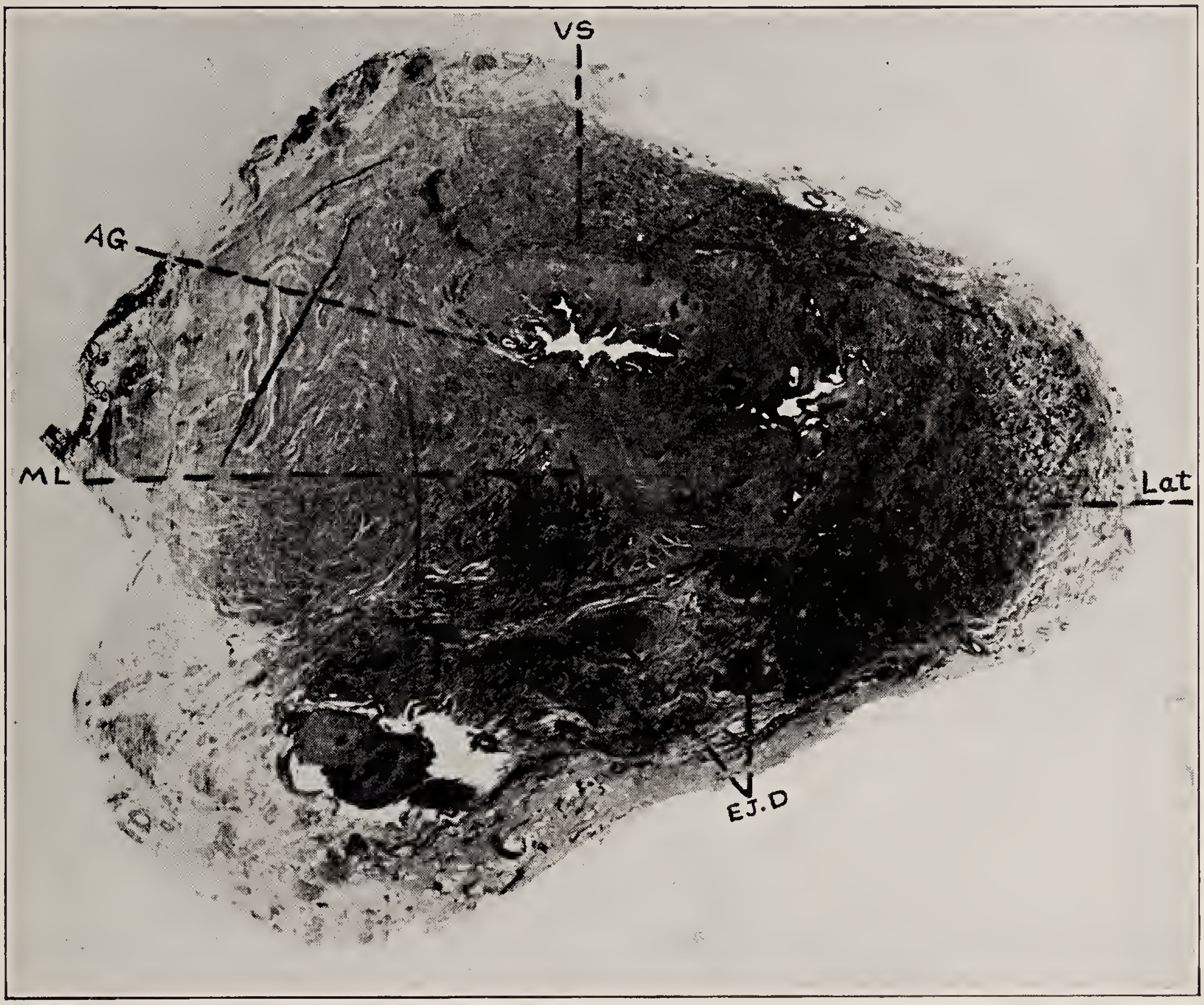

FIG. 8. Cross section through vesical sphincter of a 4-year-old boy. Ej. D., Ejaculatory ducts. Lat., Lateral lobe. ML., Median lobe. AG., Subcervical tubules (Albarran's glands). VS., Vesical sphincter.

form two muscular bands which pass downward on either side of the urethra and, at its upper level, swing medially to form a loop about the urethra (called by Wesson the external arcuate muscle of the vesical orifice). Most of the longitudinal fibers sweeping down the anterior surface of the bladder terminate at the vesical neck in the fibromuscular detrusor ring; a few follow the course of the circular fibers, while others continue downward to form an internal longitudinal layer of the urethra. The fibers from the circular layer of the bladder wall pass around the bladder to a point just opposite the vesical neck; here some of the fibers from the region posterior to the vesical orifice swing downward and forward obliquely and pass as thin bands within the loop of external longitudinal muscle, and, encircling the urethra in the region opposite the verumontanum, also form a loop about the urethra (the internal arcuate muscle). From this band other fibers branch off and extend to the prostate gland; and Wesson regards it as probable that the prostate represents the posterior portion of this collection of circular fibers encircling the urethra which has been invaded and distorted by prostatic tubules. The opening of the vesical orifice during micturition, according to this investigator, is primarily the result of contraction of the powerful trigonal muscle, which passes in the form of an arc through the weaker arcuate muscles at the vesical orifice and pulls them mechanically open on contraction.

At the lower border of the urethral loop is a sheath of striated muscle fibers which increase in number as they pass downward, but extend only about half-way around the urethra until the apex of the prostate is reached. From here on, the striated fibers almost completely surround the urethra to end posteriorly in a raphe of connective tissue behind the membranous urethra. This system of striated muscle makes up the external vesical sphincter.

The origin and development of the vesical trigone was considered in detail by Griffiths more than a half century ago (1891). He decided that this structure is composed entirely of the innermost muscle bundles of the bladder wall, the outermost bundles passing separately to participate in the formation of the bladder neck. Walker, in 1906, observed that on either side of the bladder a thick muscular band extends from the ureter down toward the urethra, at which point they converge and, uniting, pass over the margin of the urethral orifice as a continuous band of longitudinal muscle. An indiscriminate interlacing of the muscle fibers filling up the triangular space thus marked out was observed. Similar observations were made by Versari, who described the normal musculature of the vesical trigone as being made up of (1) the trigonal portion of the internal sphincter, (2) certain fibers from the musculature of the urethral walls, and (3) the muscle bundles of the sheaths of the ureters. In full adult development, there may be present muscle bundles arising in the muscular layer of the bladder wall.

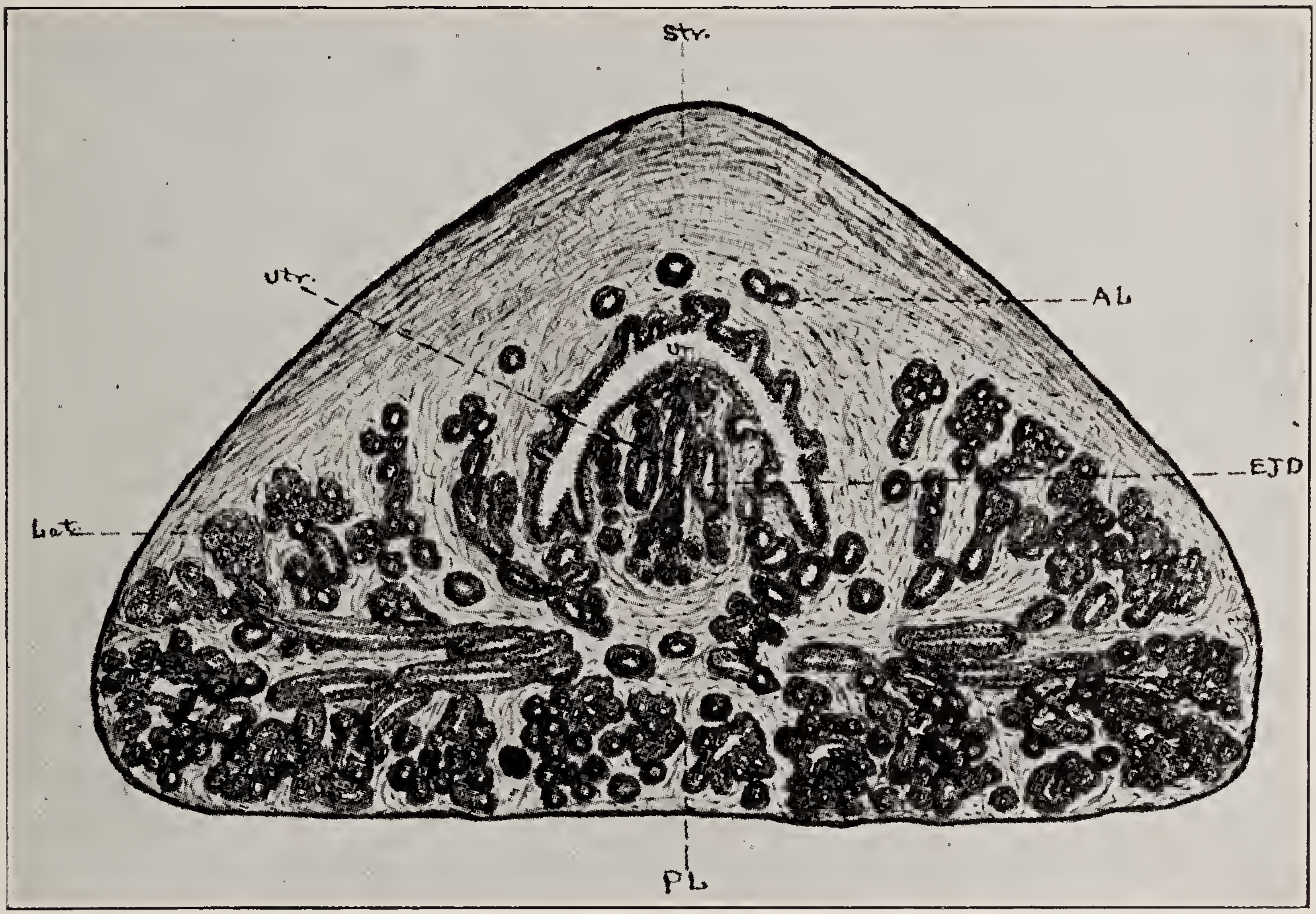

Fig. 9. Cross section through middle of verumontanum and prostate gland of a boy aged 4 years, stained according to van Gieson's method. Ur., Urethra. Utr., Utricle. Ej. D., Ejaculatory ducts. Str., Striated muscle fibers. AL., Anterior-lobe tubules. Lat., Lateral-lobe tubules. PL., Posterior-lobe tubules.

Wesson, from his extended embryological investigations, decided that the trigonal muscle is an independent structure arising from the longitudinal muscle fibers of the walls of the ureters — its embryological origin, therefore, being mesodermal, while that of the bladder fundus is entodermal. He found the beginning of muscle development in the trigone in an embryo of 21 mm. length, when separation of the bladder from the urethra has been accomplished. The trigonal muscle is superimposed upon the external longitudinal and middle circular layers of the bladder wall. Its fibers extend fanwise from the ureteral orifices, some passing medially to form the interureteric ridge, while others interlace with those from the opposite side in the middle of the trigone, and still others pass downward to the vesical orifice, forming the ureteric ridges (Bell's muscle). These two muscles converge at the vesical orifice, causing the trigonal muscle to be greatly thickened at this point. The trigonal muscle passes downward and forward over the posterior border of the vesical orifice, thinning out to form an inner longitudinal layer over the posterior aspect of the prostatic urethra and eventually reaching an insertion in the region of the verumontanum. The vesical and urethral sections of this muscular structure do not lie in a single plane but are set at an angle, which occurs at the vesical orifice. In contracting,

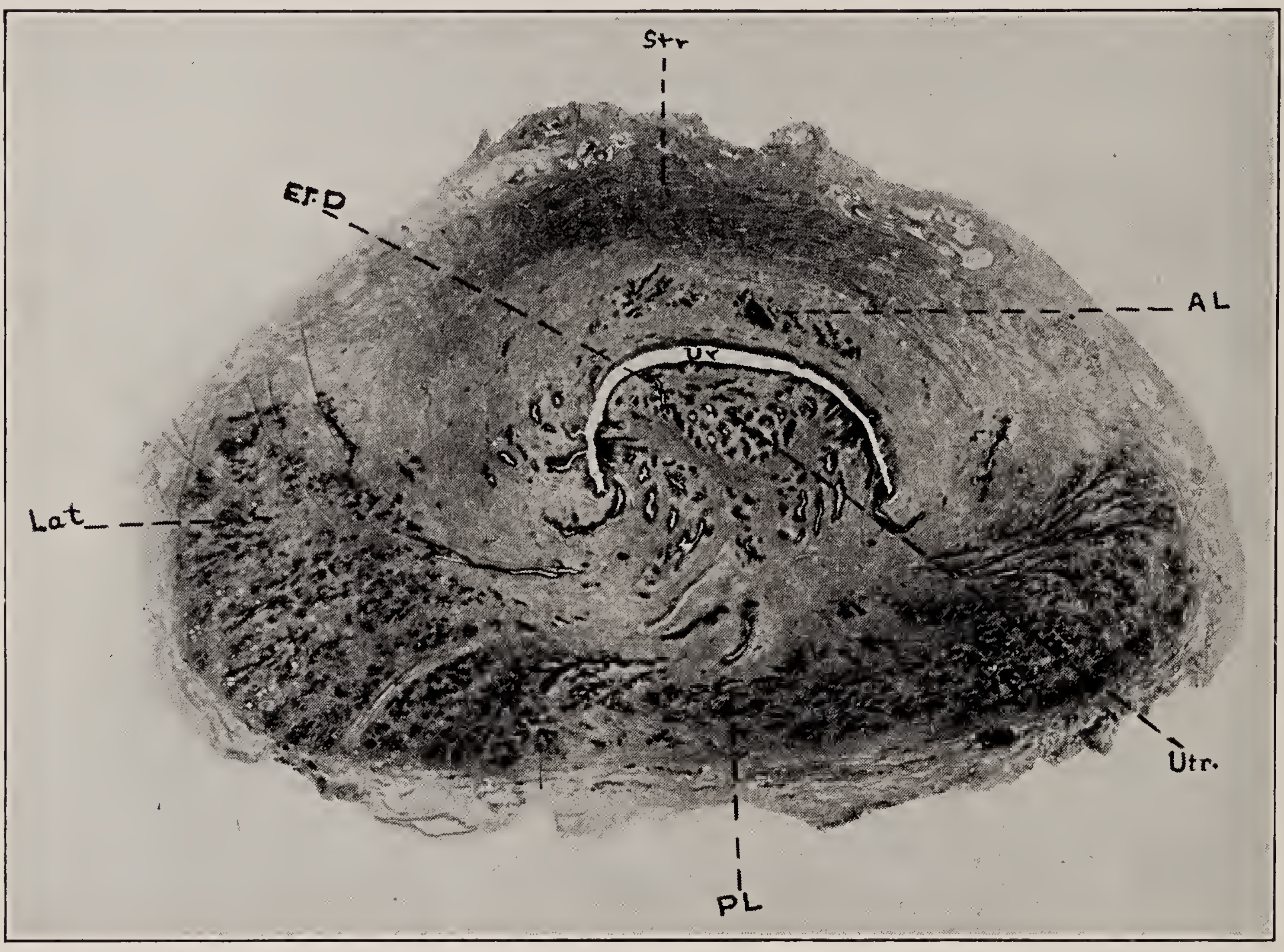

FIG. 10. Cross section through verumontanum of a 4-year-old boy. Ej. D., Opening of left ejaculatory duct into Ur., urethra. Lat., Lateral-lobe tubules. PL., Posterior-lobe tubules. AL., The inconspicuous anterior-lobe tubules. Str., Striated muscle bundles; these take a deeper stain and extend across the entire anterior portion of the prostate.

the trigonal muscle straightens out this angle and draws back the lower lip of the vesical orifice, thus pulling open the internal sphincter.

ANATOMY OF THE PROSTATE GLAND

Location. The prostate gland lies behind the second portion of the rectum at the bladder neck, which it surrounds posteriorly and laterally. It is pierced by the prostatic portion of the urethra and the ejaculatory ducts.

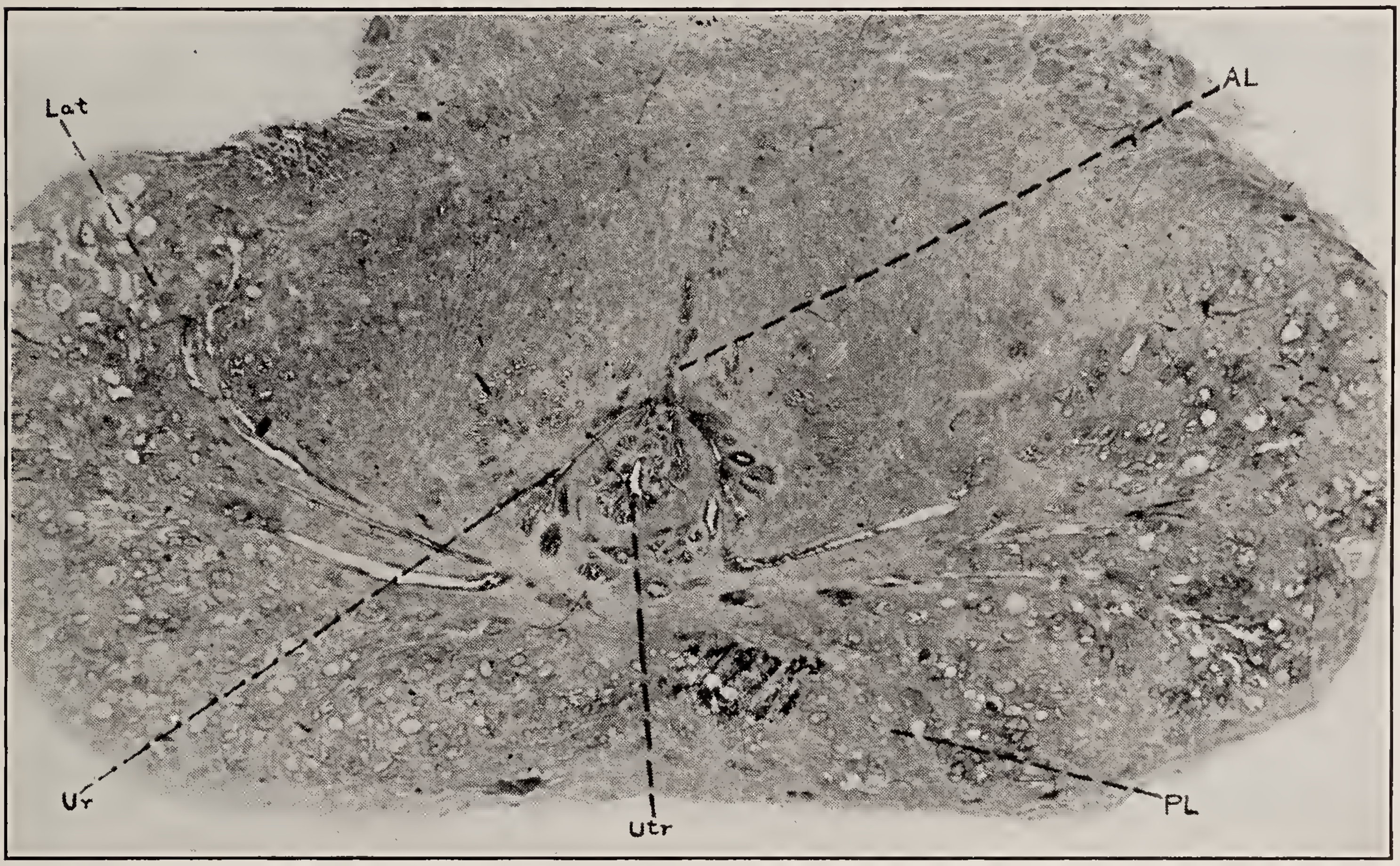

FIG. 11. Cross section through level of summit of verumontanum of a boy aged 17 years. Ur., Urethra. Lat., Lateral-lobe tubules. PL., Posterior-lobe tubules. AL., Anterior-lobe tubules, the duct of one of which is just emptying into the urethra. Utr., Utriculus prostaticus, surrounded by the tubular structures which empty into it and are contained within its sheath.

Fascial investments. The prostate is encircled by a sheath called the *prostatic fascia,* a rather thin structure which lies just outside the true prostatic capsule and contains the vessels of the gland. It is derived from the rectovesical fascia. The latter structure springs from the linea alba, passing over the internal surface of the levator ani muscle and finally dividing into three layers: (1) an upper, or anterior, layer adherent to the prostate and the pubes, which passes over the gland's anterior surface and above its venous plexus; (2) a median layer passing behind the posterior surface of the gland and under its lateral venous plexus; and (3) a lower, or posterior, layer immediately adjacent to the anterior wall of the rectum. The median and posterior layers constitute the aponeurosis of Denonvilliers, which covers the posterior surfaces of the prostate and seminal vesicles.

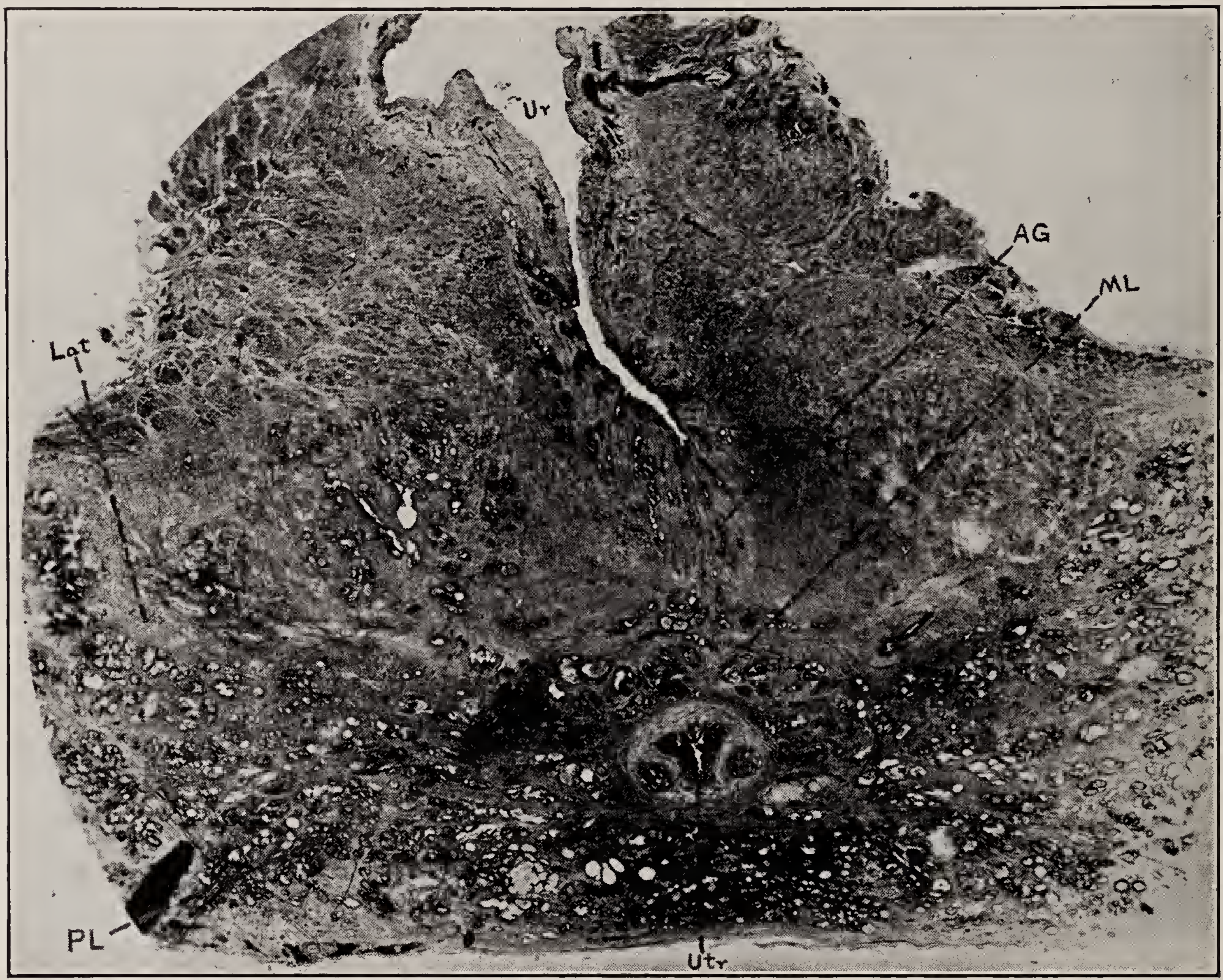

Fig. 12. Cross section at level of the region just above the upper end of the verumontanum of a man 34 years old (section cut somewhat obliquely). Ur., Urethra and portion of bladder lumen. AG., Subcervical tubules. ML., Median-lobe tubules. Lat., Lateral-lobe tubules. PL., Posterior-lobe tubules. Utr., Utriculus prostaticus and ejaculatory ducts bound firmly together in envelop.

Wallace describes the rectovesical fascia as connective tissue "simply playing the part of a packing," and thinks that giving definite names to its layers is likely to give rise to confusion and lead to "erroneous ideas, since, although able to resist considerable pressure when this is applied at right angles to its surface, it is capable of being split into innumerable planes when the cleavage is performed parallel to its surface." He continues: " It is usual to describe the fascia covering the levator ani as being reflected off this muscle and on the prostate, to form the sheath of this organ. As a matter of fact, the levator ani muscles are in close apposition to the sides of the gland, and the interval between the two is filled with a many-planed areolar tissue in which are embedded some of the veins of the prostatic plexus. Between the triangular ligament on the one side, and the anterior surface of the prostate on the other, a similar arrangement is found, and in this fascia is embedded the anterior part of the prostatic plexus."

Denonvilliers' fascia is a light-colored fibrous plane of tissue which is sometimes so thick and firm as to be almost leathery. It extends to the apex of the prostate, covering its posterior surface. Ordinarily, it is semilunar in outline, the lowest point of the concavity being just above the point where the vasa deferentia approach each other and become ensheathed in the same envelop. Laterally, the fascia projects in a hornlike process for a short distance beyond the surface of the prostate on each side, covering the posterior surface of the seminal vesicles and merging, above the upper end of each vesicle, with the fatty and areolar tissue surrounding the vesicles and vasa deferentia. This firm barrier between the posterior surfaces of the prostate and seminal vesicles and the rectum is an important factor in preventing the extension of malignancy from the genital tract to the rectum.

Denonvilliers' fascia adheres with moderate firmness to the posterior surfaces of the vesicles and prostate except at the upper border of the posterior lobe of the latter, where it is so intimately attached that it can be dissected free only with the greatest difficulty. Except for its upper border, the fascia is a sharply defined structure throughout. In specimens where the upper border is not of semilunar outline, it often extends further upward, even directly across from the upper end of one seminal vesicle to that of the other, so that the marginal outline is much less concave.

The vascular supply is limited, practically all of the small vessels which may be seen coursing through the tissue being confined to the upper layer, or that portion in contact with the vesicles and the prostate.

Appearance. The prostate gland has somewhat the shape of a heart, flattened. Its posterior surface, which faces the anterior surface of the rectum, is triangular and flattened, and usually has a depression extending longitudinally in the midline; this is most prominent toward the base and rarely existent at the apical third. The upper border bulges on either side, and receives the ejaculatory ducts — after the junction of the vasa deferentia with the seminal vesicles — in an elliptical funnel-shaped depression. The lateral borders are rounded and prominent, the lateral lobes making up the main mass of the gland. Between the lateral borders and the prostate's upper surface lies a sharply defined area. In young specimens, obtained before puberty, there is far less lateral bulging, but the general contour is about the same.

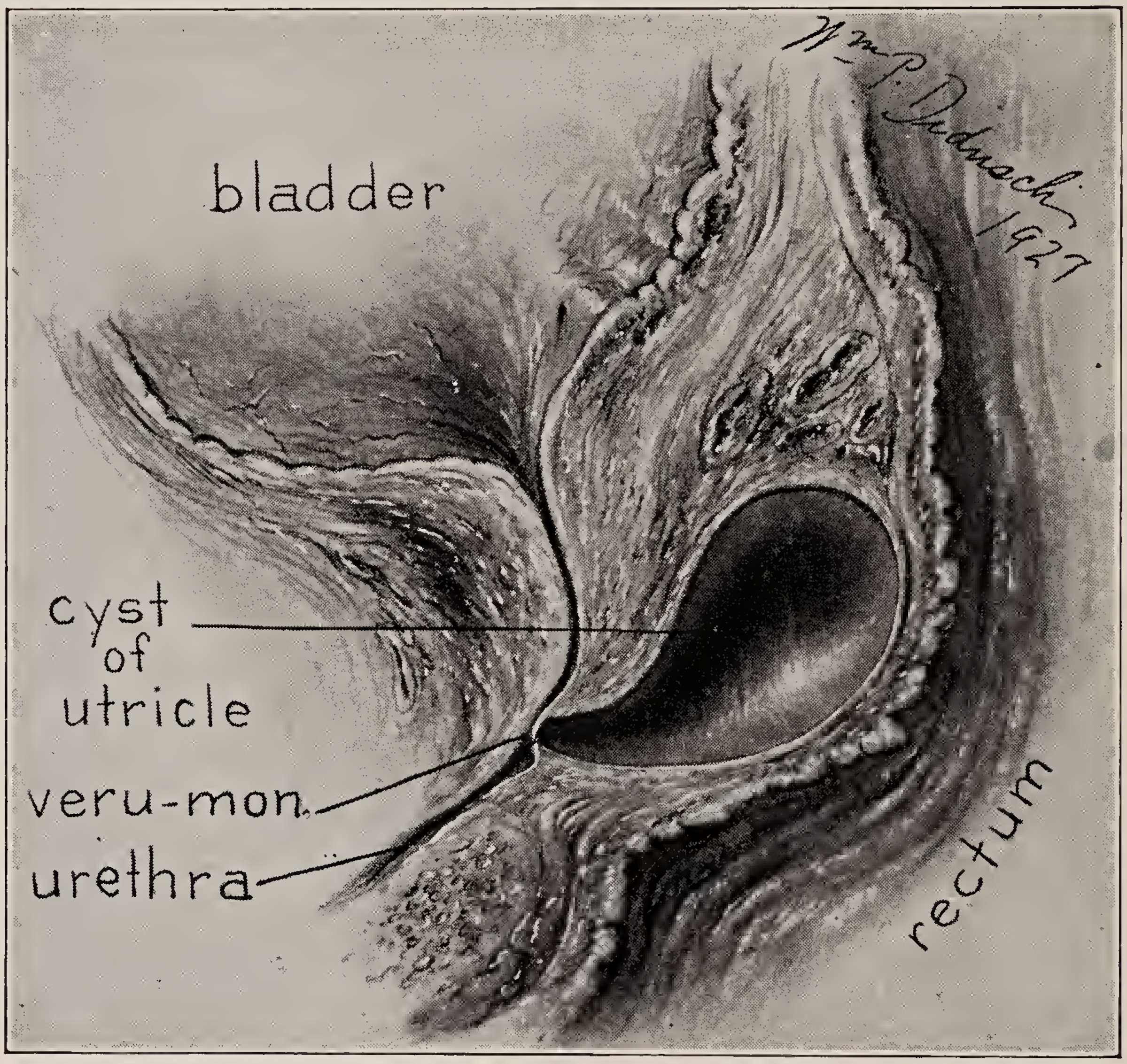

Fig. 13. Cyst of the prostatic utricle, which grew to such proportions that it endangered the life of the patient; here shown as the only specimen of its sort on record. (Observed in Museum Felix Guyon, Hôpital Necker, Paris, and published here with the permission of Prof. Legueu.)

Size. Measurement, by the author, of 224 specimens obtained from routine autopsies showed that in every instance the width of the prostate is greater, and its thickness less, than the antero-posterior diameter. There is always greater prominence of the lateral than of the middle portions of the base, so that in adult prostates the distance from the apex to the lateral prominences exceeds that from the apex to the middle of the base by 0.02 cm. to 0.5 cm.

Specimens from the first decade of life were obtained mainly from subjects less than 5 years of age. As there is only a very gradual growth of the gland during these first 5 years, the prostate of a child at this age is but little larger than that of the newborn. The average length of the prostate during the first 5 years is 1.2 cm., the width 1.5 cm., and the thickness 0.9 cm.

As is to be expected, there is a great increase in the size of the gland after the twelfth year — an increase, indeed, that is proportionately greater than that observed in other organs of the body during the same period. The enlargement apparently affects to the same degree all the lobes except the anterior, and there is a corresponding increase in the interlobular and intralobular connective tissue. The muscular tissue surrounding the tubular elements becomes greatly thickened, although in the mucosa there is no marked change. One specimen, removed from the body of a boy aged 17 years, measured 2.28 cm. in length, 3.9 cm. in width, and 1.8 cm. in thickness, indicating a nearly 100 per cent. increase in the dimensions of the prostate during the period of puberty. Ten specimens over 15 years and under 20 years of age averaged 3.0 cm. in length, which is more than twice the length of the average prostate during the first decade. The average width, during the second decade, is 3.8 cm., and the thickness 2.1 cm.

During the third decade, the prostate gland reaches adult size — but few changes, and those comparatively slight, occurring after this period. The average length is 3.3 cm., the width 4.1 cm., and the thickness 2.4 cm. These figures vary considerably from those of other observers. Wilson and McGrath consider the average adult prostate to be 3.4 cm. in length, 4.4 cm. in width, and 1.5 cm. in thickness, with a weight of 16 or 17 grams. Cuthbert Wallace places the average length at 3.0 cm., the width at 3.6 cm., the thickness at 1.8 cm., and the average weight at 20.5 grams. Piersol places the average length at 3.5 cm., the width at 4.3 cm., the thickness at 1.75 cm., and the weight at 22 grams. Teem, in 1936, gave the average measurements and weight of 33 normal prostates as: length, 3.08 cm.; width, 3.84 cm.; thickness, 2.7 cm.; weight, 20.7 grams. Sir Henry Thompson, writing in 1873, gave the average measurements of 50 normal adult prostates as: length, 1.4 inches;

width, 1.75 inches; thickness, 0.7 inch; and the average weight as 18.5 grams. His figures correspond fairly well with those of Deschamps, Senn, Gross, and Hodgson, but are somewhat smaller than those of Dupuytren.

During the fifth and sixth decades of life, there is a slight increase in all the dimensions of the prostate, but this averages only a few millimeters. In old age, there is a noticeable decrease in size, so that specimens taken in the senile period resemble those of the third decade more than those of any other period of life. Specimens obtained during this period are either a little smaller and more

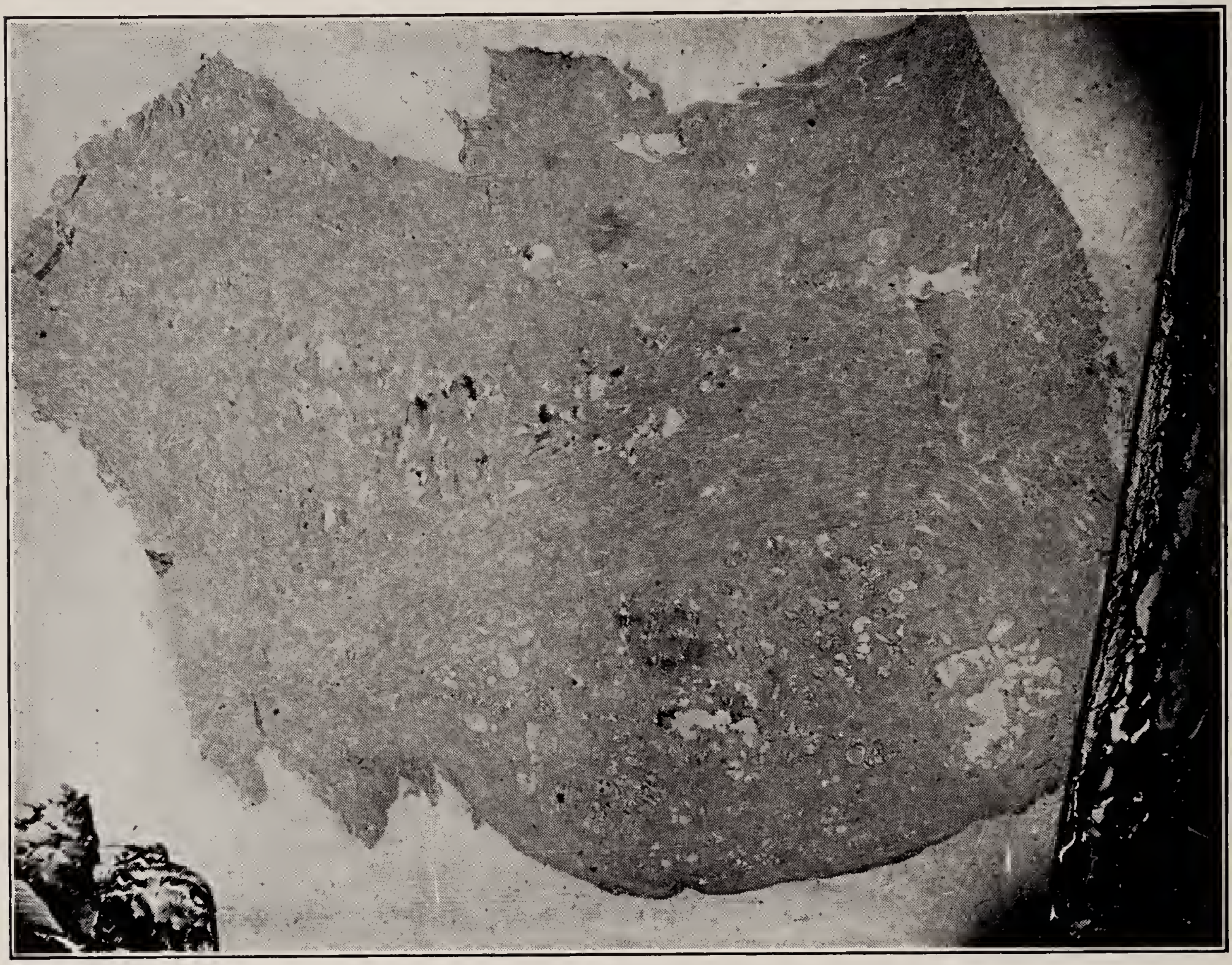

FIG. 14. Photomicrograph of cross section through the vesical orifice of a man with an enlargement of the subcervical group of tubules. Note the moundlike elevation of the floor of the vesical orifice caused by hypertrophy of the subcervical tubules. Under the high power of the microscope, the tubules are shown to have the same type of mucosa seen in embryonic prostatic tissue; this is composed of many layers of cuboidal cells, while the adult prostatic mucosa is made up of a single layer of cylindrical cells. Beneath the subcervical tubules are clearly seen the muscle fibers composing the vesical sphincter. Below the sphincter are seen the tubules of the prostate gland proper.

atrophic in appearance than those of the preceding age period, or a little larger and displaying the characteristics of hypertrophy. It should be mentioned in this connection, however, that prostate glands obtained from elderly and aged subjects show more abnormalities than those of other age periods: 51.1 per cent. of our series showed some deviation from the normal, and about one-third of all specimens examined, which were taken from men over 60 years of age, showed more or less adenomatous hypertrophy.

The glandular structure of the prostate. The prostate is a musculo-glandular organ of the compound tubulo-alveolar type.

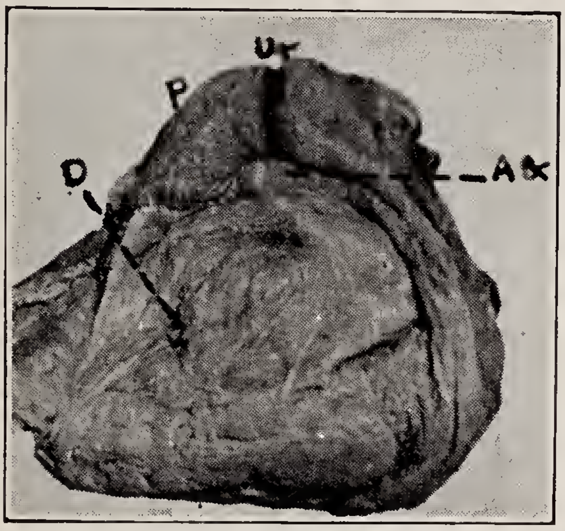

FIG. 15. Specimen showing hypertrophy of subcervical group. AG., Contracted trigonum vesicæ, with marked bas fond. D., Diverticulum of bladder. P., Prostate gland. Ur., Urethra.

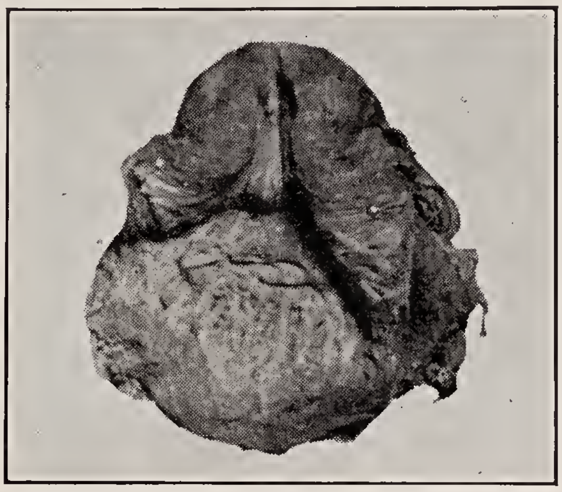

FIG. 16. Trilobe enlargement of subcervical group, with marked signs of obstruction.

The glandular portion consists of two distinct types of secreting tubules: (1) external, or prostatic glands proper, which make up the major portion of the gland, and (2) internal, or periurethral glands.

The prostate glands proper consist in units of follicle-like tubules, each equipped with its excretory duct which opens into the prostatic urethra. These units are alveolar in type, beginning to branch about a centimeter from their orifices and, after giving off several subdivisions, ending in alveoli. The alveoli are lined by the usual simple columnar epithelial cells, their inner portions often showing acidophile granules. A pseudostratified epithelium, with two rows of nuclei, occasionally is present (Rudinger). The basement membrane consists of delicate connective tissue threads

(Walker). The ducts are supplied with a mucous membrane composed of simple columnar cells except at their orifices, where they are replaced by transitional epithelium similar to that of the posterior urethra.

The periurethral, or inner, units of tubules consist of (1) small, mucosal tubules located in the roof of the urethra over the verumontanum, and (2) longer, branching submucosal glands, whose ducts open into the prostatic urethra alongside those of the prostatic glands proper. The periurethral glands are of great clinical importance because it appears that prostatic hyperplasia arises from them and not from the prostatic glands proper.

Musculo-connective-tissue portion. The musculo-connective-tissue portion of the prostate is composed of smooth muscle cells and many elastic-tissue fibers. Within is a dense fibromuscular mass, which surrounds the urethra and sends out muscle bands of transverse and longitudinal fibers that spread in all directions, usually following the connective tissue framework but sometimes themselves constituting the interalveolar septa, no admixture of fibrous tissue being discernible. Smooth muscle fibers surround each tubule and its duct to the urethral opening, those encircling the ducts being intimately connected with the circular muscle coat of the urethra. By their contractions these muscle fibers serve to empty the tubules and ducts of their secretory products.

The internal sphincter (sphincter vesicæ) and the external sphincter (sphincter urethræ) are intimately connected with the sheath and muscular stroma of the prostate; but the innervation of the musculature of the prostatic tubules is entirely independent of that of the sphincters, and is for the sole purpose of expressing the prostatic secretion into the urethra. The prostate remains entirely passive during the act of urination, which is a function of the neuromuscular system of the bladder and urethra.

The prostatic capsule. The prostate gland is enclosed in a fibromuscular capsule which is so intimately connected with the surrounding fascia that, in most instances, it would be impossible to distinguish between them were it not for the fact that the latter contains the venous plexus and, by using this for a guide, the fascia can usually be separated from the capsule proper. When they have been dissected apart, the capsule emerges as a rough membrane covering the entire prostate, composed of involuntary muscle and fibrous tissue, and so firmly attached that any attempt to strip it off carries away part of the underlying prostatic tissue. Prolongations from the capsule extend into the parenchyma of the gland, separating the outer portion of the lobes.

The arterial system. The main source of the arterial supply of the prostate is the genitovesical artery, which is derived from the anterior branch of the internal iliac artery. The internal pudic and middle hemorrhoidal arteries send a few small branches to the lower portion of the gland.

The genitovesical artery, after passing over the surface of the levator ani muscle to the bladder base, sends branches to the bladder (inferior vesical artery) and the prostate (prostatic artery). The prostatic artery, as shown by R. H. Flocks and others, gives rise to two groups of arteries. The urethral, or inner, group penetrates the tissues at the prostatovesical junction and supplies the bladder neck and the inner, or urethral, portion of the prostate gland except in the region adjacent to the verumontanum. These are large vessels, which anastomose freely about the circumference of the urethra. The capsular, or outer, group courses along the posterolateral surface of the prostate and sends branches dorsally and ventrally in a radial manner to supply the outer two-thirds of the

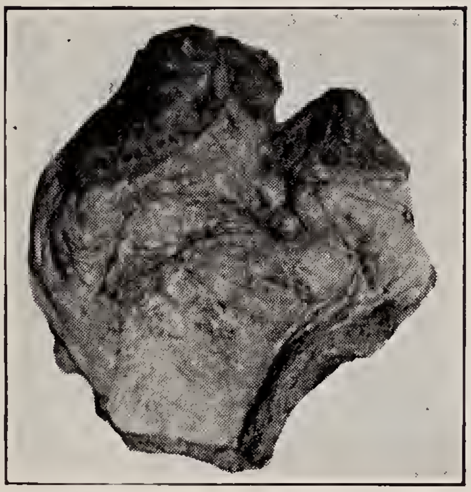

Fig. 17. Hypertrophy of subcervical group in three distinct portions, practically blocking the urethra. (Courtesy of Journal of American Medical Association.)

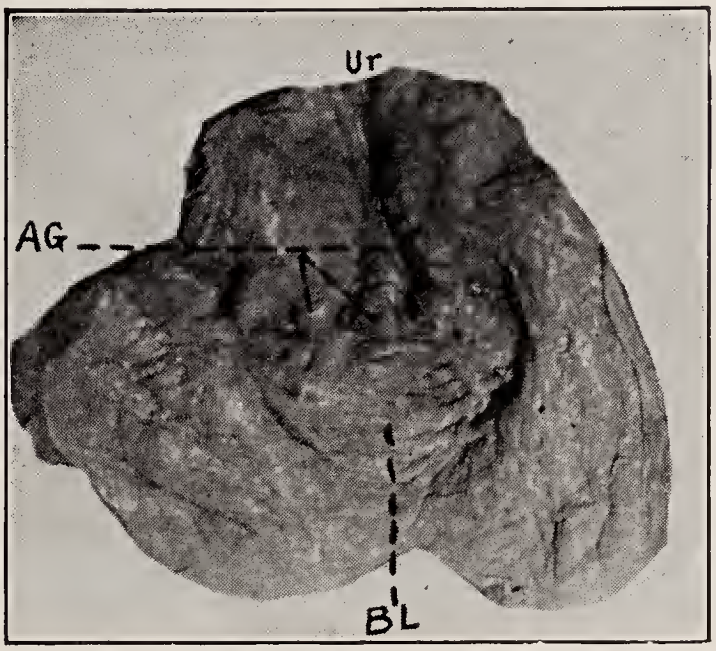

Fig. 18. Specimen showing marked enlargement of subcervical group in three distinct portions, which are very large and almost completely block the urethra. BL., Fundus of bladder, showing marked signs of obstruction. AG., Subcervical tubules, divided into three portions. Ur., Urethra at apex of prostate gland.

gland. These branches anastomose to a moderate extent with branches of the urethral group. In the most distal part of the prostate, branches of the capsular plexus penetrate deeply to supply the prostatic tissue adjacent to the verumontanum.

The venous system of the prostate. Some of the veins from within the glandular tissue and around the ducts, on emerging from the prostate, are grouped in a series of large channels in the lateral ligaments, where they form the vesical plexus. The remainder pass into the prostatic plexus (of Santorini), a rich venous plexus lying between the anterior surface of the prostate and the symphysis pubis and behind the inferior pubic ligament. This plexus receives not only the blood from the prostate but also that from the deep dorsal vein of the penis, and communicates freely with the vesical and hemorrhoidal plexuses, eventually emptying into the internal iliac veins.

The lymphatic system. The lymph vessels arise in networks surrounding the alveoli, and unite to form larger vessels which communicate with a fine network on the surface of the prostate. Within, though numerous at the base of the gland, there are but few at its apex. At each side of the prostate, the lymphatic plexus forms two trunks: a superior, passing to the obturator lymph nodes of the pelvis, and a lateral, passing to the internal iliac lymph nodes (Sappey). A finely granular protoplasm composes the endothelial cells of these lymphatics.

Innervation of the prostate. The nerve fibers of the prostate arise in the hypogastric plexus (sympathetic) and in the third and fourth sacral nerves. In their branches are observable both medullated and nonmedullated fibers, and ganglion cells of relatively large size. Within the prostate the nerves ramify and terminate in muscles and the epithelium of the tubules.

Pathological conditions of the prostate, as has long been recognized clinically, are accompanied by severe nervous disturbances, the most common being the referred pains which occur in the small of the back, in or about the rectum, or down the legs. Various investigators, notably Timofeew and von Planer, have described a complicated system of nerve fibers and endings which assists greatly in explaining this feature of the anatomy of the prostate. Von Planer describes numerous nerve-endings situated in the superficial layer of the mucosa of the prostatic urethra; and Timofeew, in a very complete study, tells of a wide-mouthed plexus of medullated fibers within the deeper layers of the capsule.

From this plexus, fine nonmedullated fibers pass through the prostate and, branching freely, end between the epithelial cells. Some branches form tuftlike end-bodies. Others form encapsulated end-organs, some of which resemble Pacinian corpuscles, with two fibers each, one of which is thick and enters as a naked axis cylinder, ending in the opposite pole as a pointed or knoblike structure; the other is thin, loses its medullary sheath, forms a finely divided fibrillary web, and surrounds the axis cylinder of the first fiber as a loose tunic, although it does not come in contact with it. Still others end as a single fiber more or less branching in all stages of transition from the simplest cylindrical form up to the

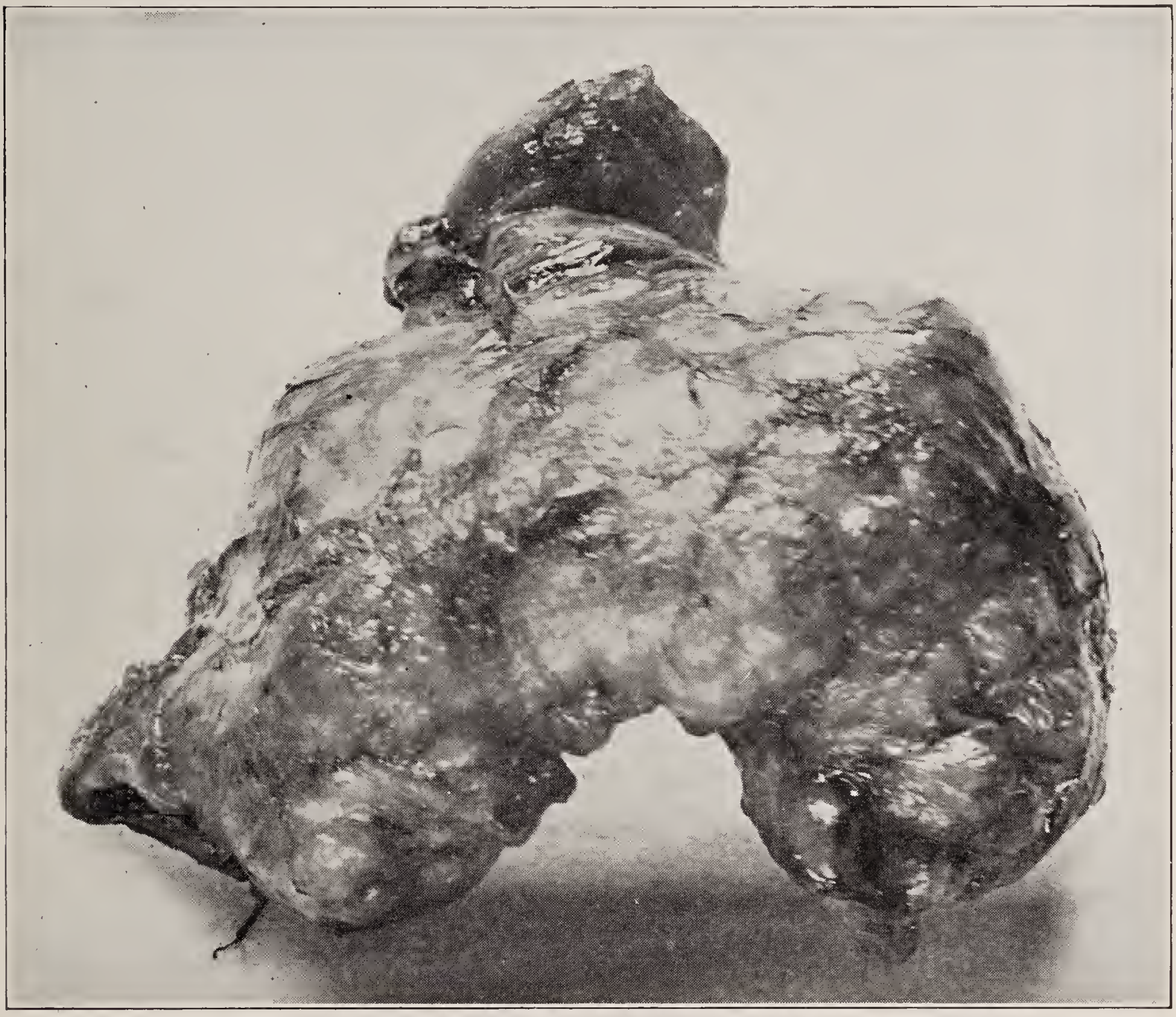

Fig. 19. Posterior view of a prostatic specimen showing the line of demarcation caused by the vesical sphincter beyond which the subcervical enlargement extended. The latter occupied a most strategic position and, in this case, was almost entirely responsible for the complete retention suffered by the patient.

multiple branching forms, in addition to the usual Pacinian corpuscles. Besides the sensory fibers, Timofeew mentions the presence of many others, which are apparently secretory as they resemble similar fibers in other glandular structures. The nerves of the smooth muscle fibers are nonmedullated, and form, between the muscular layer, thick plexuses of varicose fibrillæ which send out numerous branches.

Adjacent group of glandular tubules: subcervical (Albarran's) tubules. Near the internal vesical sphincter lies a group of glands which seem to be of independent origin and to have no functional relationship to the prostate gland. The most easily recognized of these are the subcervical group of tubules first described by the great French urologist, Albarran. These lie beneath the neck of the bladder, and consist of 30 or more branched tubules the ducts of which open proximal to the verumontanum in the middle of the urethral floor. Most of the subcervical tubules lie in the mucous membrane inside the vesical sphincter, although a few may go down as far as the submucosa. The structure of these tubules is less complicated than that of the prostatic tubules, and they lack a definite muscular and connective tissue stroma. In some specimens the prevailing cell of the mucosa of the group is cuboidal. In health, these tubules are never surrounded by the muscular or other differentiated tissue envelops which characterize the structure of the true prostatic tubules.

The subcervical group of tubules is of great surgical importance because their anatomical location subjects them to influences which often produce pathological conditions. A study, by the author, of more than 350 prostates collected from routine necropsies showed enlargement of this group in about 25 per cent. of the subjects over 30 years of age. In practically all cases of benign prostatic hypertrophy there is a considerable degree of accompanying enlargement in these accessory glands, which is apparently stimulated by the same factors that influence prostatic hypertrophy. Furthermore, it appears that the subcervical glands respond to this stimulating influence even earlier than does the prostate gland proper.

Subtrigonal (Home's) group of tubules. Another group of tubules is found in the mucosa of the vesical trigone, usually below the center and occasionally as far anterior as the apex of the prostate; these reach, and at times penetrate, the submucosa. The subtrigonal tubules are generally simple, those from younger specimens having no branches, while those of the middle-age period have one or two branches. Their histological structure is not distinctive, the lining being of transitional epithelium similar to that of the bladder, with cells piled up five or six deep in some cases. The lumina are usually quite small.

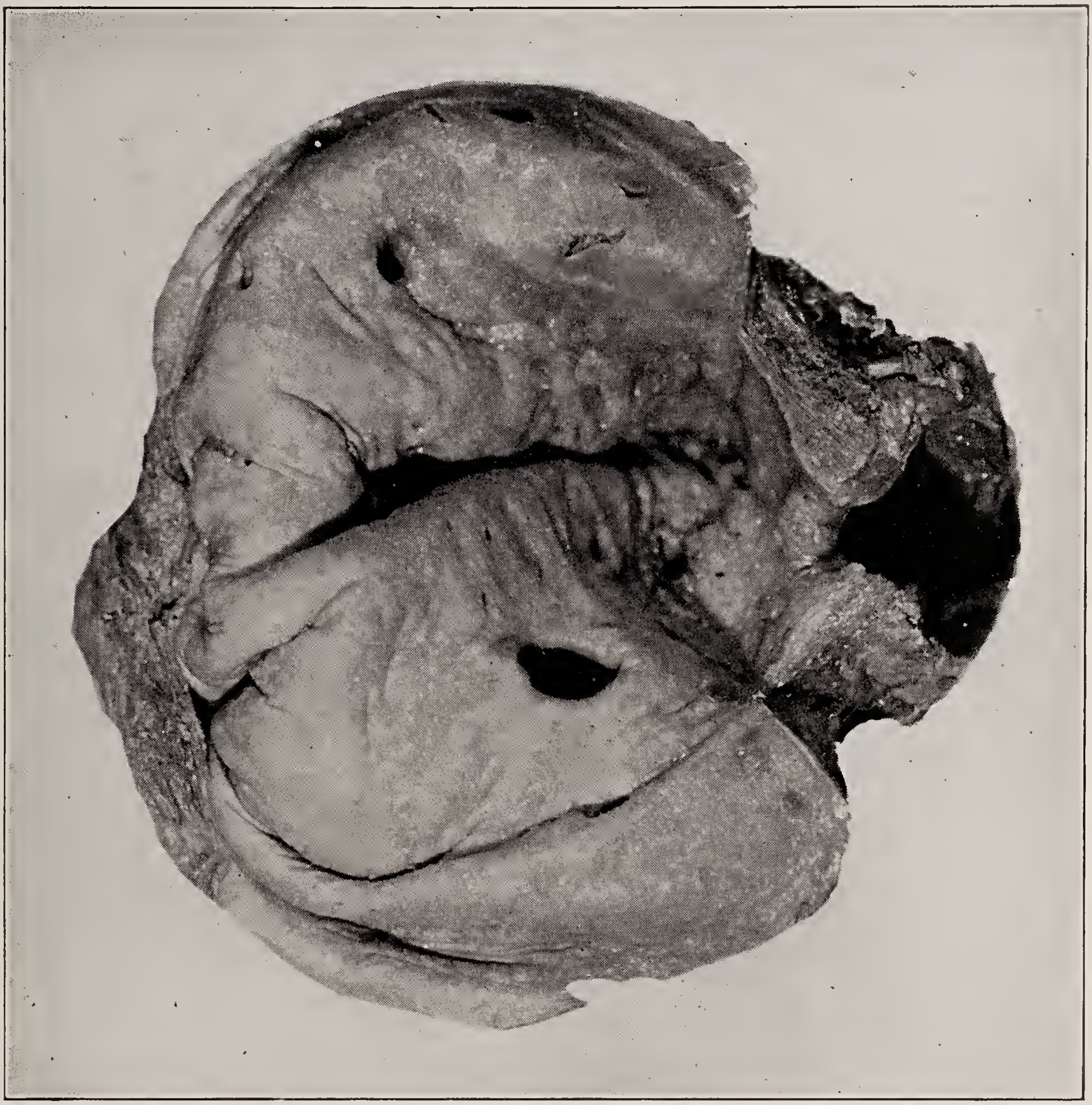

Fig. 20. Specimen showing enlargement of the subcervical group of tubules in horseshoe form on the floor of the vesical orifice, resulting in grave obstruction with multiple diverticula of the bladder. (Courtesy of Journal of American Medical Association.)

These tiny structures are of surgical importance for two reasons: first, because their location is such that any overgrowth may impede evacuation of the bladder; and second, because enlargement of the group occurs often enough to merit the consideration of its possibility in the diagnosis of any pathological condition involving the region of the bladder neck. Cases have been observed in which these tubules became enlarged and further growth caused them to become almost free in the vesical cavity, being connected with their site of origin only by a small pedicle. When urination was attempted, this globular mass fell into the orifice of the urethra, blocking it more completely than would have been the case had an enormous adenomatous prostate been present.

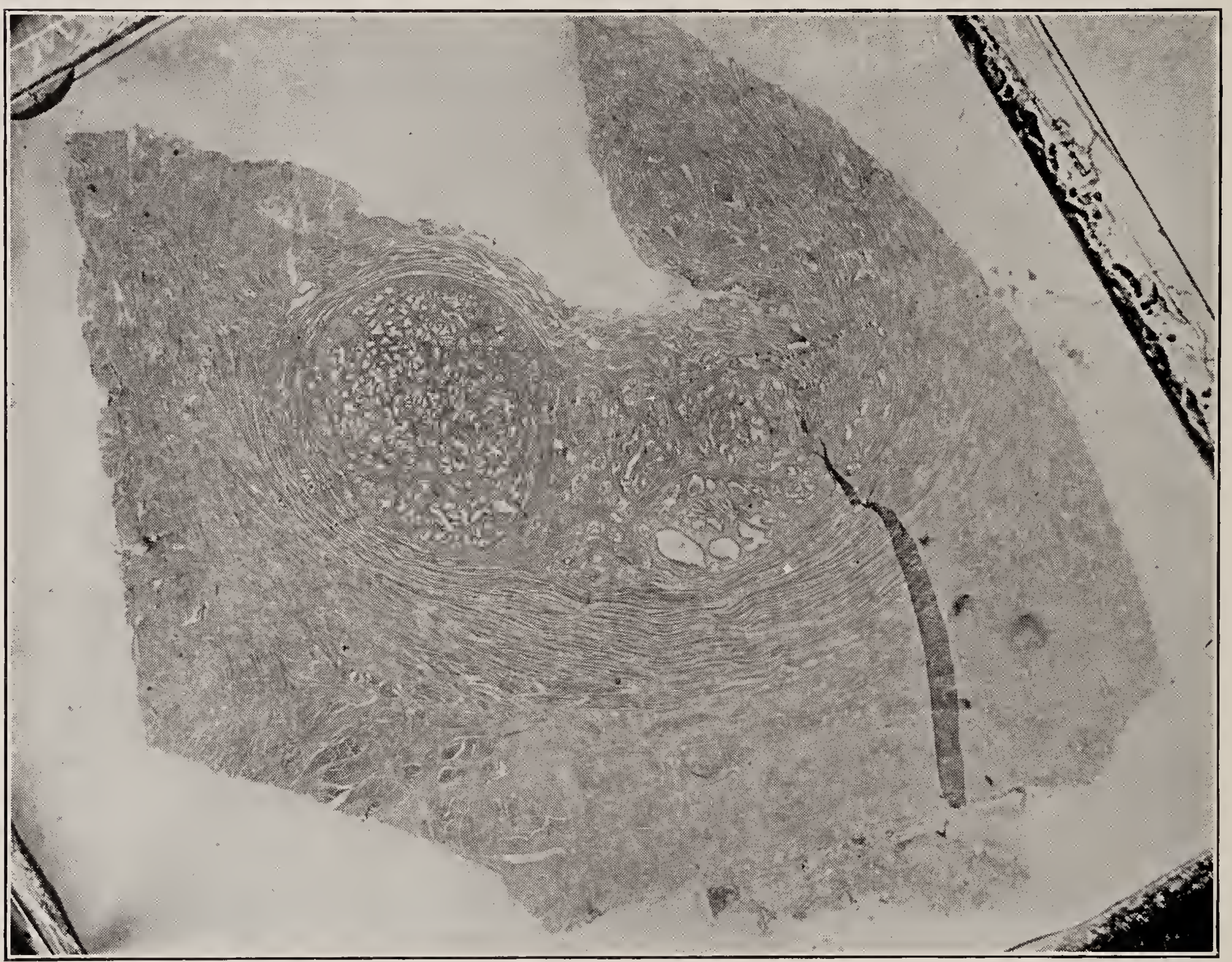

Fig. 21. Photomicrograph of cross section through a horseshoe-shaped intrusion on the floor of the vesical orifice shows one spheroid. Outside of the obstructing mass are clearly seen the muscle fibers of the internal sphincter.

Other structures in the region of the vesical orifice. In the posterior portion of the urethra is a longitudinal elevation some 3 cm. in height — the verumontanum. This tapers off gradually at both ends; and upon its anterior aspect is the slitlike opening of the prostatic utricle — a longitudinal, piriform pouch which extends backwards between the ejaculatory ducts. The orifices of the ejaculatory ducts lie on the right and left borders of the verumontanum, thus serving to divide the prostatic portion of the urethra into a proximal and a distal section. The orifices of the ducts of the lateral lobes of the prostate lie on either side of the verumontanum, while the ducts of the middle lobe open proximal to the verumontanum upon the posterior wall of the urethra. When ducts from the anterior lobe are present, they will be found to open upon the anterior urethral wall.

As was pointed out by Wilson and McGrath, the common custom of considering the subdivisions of the prostate from the standpoint of its external form alone ignores the organic divisions, that is, the zones of glandular distribution. An exact comprehension of the glandula prostatica can only be acquired by freeing the gland, with its lobes and lobules, from the surrounding musculature. Thus defined, these glandular lobes present agglomerations of lobules of each individual group by the fact that their excretory ducts open in common at a definite place in the urethra, and are to be designated prostatic lobes in the strict sense. Consequently, following this principle of classification, the glandula prostatica, more or less independently of its outer form, consists of two symmetrical peripheral lobes (the lateral lobes), an interposed middle lobe, a small anterior lobe, and a posterior lobe.

PHYSIOLOGY OF THE PROSTATE GLAND

Secretory function of the prostate. The earlier conception of the prostate, as an essential part of the urinary apparatus and only secondarily concerned in the genital function, has given way to a recognition of its importance in the male genital complex and its nonparticipation in the function of urination. The evidence classing it as a sexual instead of a urinary organ has been thus summed up by C. W. Wallace: (1) It is confined to the male sex; (2) it enlarges rapidly at puberty along with the other sexual organs; (3) it exhibits seasonal activity in animals, such as the mole and hedgehog, which mate only at certain seasons of the year; (4) it fails to grow in persons castrated in youth; (5) it atrophies in men castrated in adult life. As removal of the prostate gland does not necessarily render a man incapable of reproduction, it is evident that it is of only secondary importance.

The only proved function of the prostate gland is the production of an external secretion which, together with the secretions of the seminal vesicles, the bulbo-urethral glands of Cowper, and the mucous glands of the urethra, mixes with the testicular secretion at the time of ejaculation to form the seminal fluid. The prostatic fluid supposedly dilutes the testicular and seminal vesicular secretions, and separates and activates the spermatozoa. However, the fact that impregnation has repeatedly been effected with spermatic fluid aspirated directly from the testicles seems to indicate that the admixture of prostatic secretion is not vitally necessary to the life or activity of the spermatozoa. The prostatic secretion also supposedly coagulates the secretion of the seminal vesicles. Launois long ago noted that the prostate does not become an active gland of secretion until puberty, this activity being coincident with the formation of spermatozoa in the testicles. The sexual activity of the gland continues to increase until after the twenty-fifth year, but by the thirtieth year this power is apparently stationary, and shortly thereafter it begins to decline. After the fortieth year the fibromuscular stroma becomes relatively thicker, which may be regarded as the first harbinger of senility.

The formation of an internal secretion by the prostate has not been proved.

The prostatic secretion. Normal prostatic secretion is rather thin, slightly viscid, opalescent, of an alkaline or neutral reaction, and has a characteristic aromatic odor. As it contains 2 or 3 per cent. of solids, its specific gravity is less than that of urine, of which the solids make up about 5 per cent. The chief solid constituents are sodium chloride (0.5 to 1 per cent.) and albumin in the form of nucleoproteids, fibrinogen, and mucinoid substances (0.35 to 0.75 per cent.). There are traces of potassium, magnesium and calcium chloride, and of calcium and magnesium sulphate. The milky appearance of the fluid is due to the presence of small, translucent, moderately refractile lecithin bodies, which are usually embedded in the amyloid constituents of the secretion. Corpora amylacea are regularly found and have been attributed to coagulation of the albuminous glandular contents together with cellular disintegration. Morphological elements, such as epithelial cells, leukocytes, and erythrocytes, are found in varying numbers, as well as occasional hyaline globules. An important ingredient of the prostatic fluid is its specific enzyme, the exact nature of which is unknown, but which supposedly coagulates the secretion of the seminal vesicles and favors retention of the seminal fluid within the female genital canal, thus promoting impregnation.

Interrelationship of the prostate, testicles, and hypophysis. The prostate is the most important of the accessory sexual glands of the male. Its intimate relation to the testicles is shown in the marked glandular atrophy following castration, or, if castration is performed before puberty, in the arrested development of the prostate.

That there is an hormonal balance among the testicles, the prostate and other accessory sexual glands, and the hypophysis is an established fact. The testicles function only when stimulated by certain substances that normally are supplied by the anterior lobe of the pituitary. The activity of the pituitary, on the other hand, is normally held in check by gonadal secretions. Evans has isolated two substances from the anterior lobe: a sex-stimulating (gonadotropic) hormone, and a growth-stimulating hormone. Much clinical and experimental study has established that castration leads to hypertrophy of the hypophysis, which is associated with characteristic histological changes in the anterior lobe and an increased secretion of gonadotropic hormone. It has also been established that injections of the pituitary gonadotropic hormone, through stimulation of the testicles, produces prostatic hypertrophy; whereas castration is followed by atrophy of the prostate and certain histological changes consisting of decrease in the size of the cells and marked increase in interacinar stroma. In castrated animals, neither hypophyseal implants nor injections of the pituitary gonadotropic hormone prevent the usual atrophy of the prostate and seminal vesicles. Injections of lipoid extracts of androgenic substances from bulls' testes into castrated animals, however, prevent atrophy of the prostate and vesicles; and feeding of desiccated bulls' testes to normal adult male rats, or the injection of the aqueous extract, over a period of time, results in hypertrophy of the prostate and vesicles.

Because of these and other experimental findings, it is now believed that there are two testicular hormones: (1) the male sex hormone (androtin), which is believed to be derived from the interstitial cells and is produced only upon stimulation of the pituitary gonadotropic hormone; (2) a hypothetical substance (inhibin, contruin), which is supposedly secreted by the germinal cells of the seminiferous tubules, and is believed to inhibit the anterior pituitary action on the accessory sexual glands of the male. Androtin is necessary to maintain the prostate in the normal state, but an excessive amount is capable of producing hypertrophy. Experimentally it has been proved that the pituitary gland can stimulate the testes to the production of enough androtin to cause hypertrophy of the prostate in rats. The absence or reduction of inhibin, it is believed, leads to excessive secretion of the pituitary gonadotropic hormone, which, in turn, stimulates the secretion of androtin sufficiently to produce prostatic hypertrophy.

There is much still to be learned regarding the exact relationship of the prostate with the testes and the hypophysis, and the mechanism of the various glandular secretions; but that the interrelationship is an intimate and exceedingly complex one is well established.

ANOMALIES OF THE PROSTATE GLAND

Malformation of the prostate, unassociated with other developmental anomalies, is extremely rare. Anomalies of the prostate, seen in conjunction with other developmental irregularities, occur more frequently. Young has remarked that "the close association, both embryologically and physiologically, of the testicle with the prostate, and the dependence of the latter upon the former for its proper functioning and development, make the prostate peculiarly susceptible to abnormalities of the testicle." Arrested development or malformation of the prostate is usually seen in association with cryptorchidism; less often with exstrophy of the bladder, with complete epispadias. There have been reported a number of instances of monorchidism with nondevelopment of the prostatic lobe and seminal vesicle on the side of the missing testicle, the prostatic lobe and seminal vesicle on the opposite side being normal.

Rarely, in endocrine deficiency, there may be complete absence of the prostate gland. In 1923, Lisser, in an extensive study of endocrine deficiency in conjunction with retarded and imperfect genital development, cited 13 cases where no prostate could be palpated. All of these patients presented other genital abnormalities, and several were mentally deficient as well.

PATHOLOGICAL CONDITIONS OF THE PROSTATE GLAND

ACUTE PROSTATITIS

Etiology and bacteriology. Prostatitis — both the acute and chronic types — is a very common disease. Since it is usually associated with inflammation of the posterior urethra, seminal vesicles, vesical neck, trigone, or even the epididymes, it should be studied in relation to both the urinary and genital tracts.

The most frequent cause of acute prostatitis is gonococcal infection. Nonspecific acute infections are also common. The organisms most often responsible are the *Staphylococcus albus* and *aureus*, *Streptococcus pyogenes*, and colon bacillus, but the *Bacillus proteus*, diphtheroid types, or other organisms may be present. Mixed infections are frequent. Contributing causes of prostatitis are masturbation, excessive sexual intercourse, and coitus interruptus.

Infection may reach the prostate by direct extension from the posterior urethra up the prostatic ducts (the most common way); or it may be descending, and secondary to an acute infection of the kidney or bladder; or blood-borne from a primary focus in the skin, sinuses, teeth, or tonsils; or a complication of a systemic infection, such as influenza. A chronic prostatitis may be exacerbated into an acute condition by unwise instrumentation and manipulation in the treatment of a chronic posterior urethritis and prostatitis.

Pathology. Three types of acute prostatitis are generally recognized. The most common is *acute catarrhal, or glandular, prostatitis*, with marked round-cell infiltration of the glandular epithelium, accompanied by proliferation and desquamation. It is always present in acute posterior urethritis, and is usually caused by direct migration of the organisms up the prostatic ducts. The contiguous structures, including the prostatic utricle, ejaculatory ducts, and seminal vesicles, may be affected at the same time. *Follicular prostatitis* follows the first type, and is characterized by the formation of small abscesses, or by distention of the prostatic tubules with retained pus and desquamated epithelial cells, which are not evacuated because of obstruction of the ducts due to temporary edema or other causes. *Parenchymatous prostatitis* is an intensification of the second stage, the small collections of pus becoming larger and a greater extent of the surrounding fibromuscular stroma becoming involved. Finally, the entire gland increases in size, being hot, tender, and tense, and may even disintegrate so that clinically it forms a large prostatic abscess.

The termination of acute prostatitis is (1) resolution, (2) the formation of a large prostatic abscess, or (3) chronic prostatitis.

Symptoms. The onset of acute prostatitis may be mild, with few or no local symptoms; or it may be very severe. When of urethral origin, the initial symptoms are usually disturbances of urination: urgency, frequency, burning, pain on urination, dribbling. The prostate gland may enlarge to the point of causing complete retention, requiring catheterization. In acute prostatitis of hematogenous origin, the attack may be ushered in by a chill or fever, and there may or may not be urinary symptoms. Pain may vary from a sense of fulness in the perineum or rectum to acute pain — in the perineum, rectum, loins, penis, or above the pubes. There is leukocytosis.

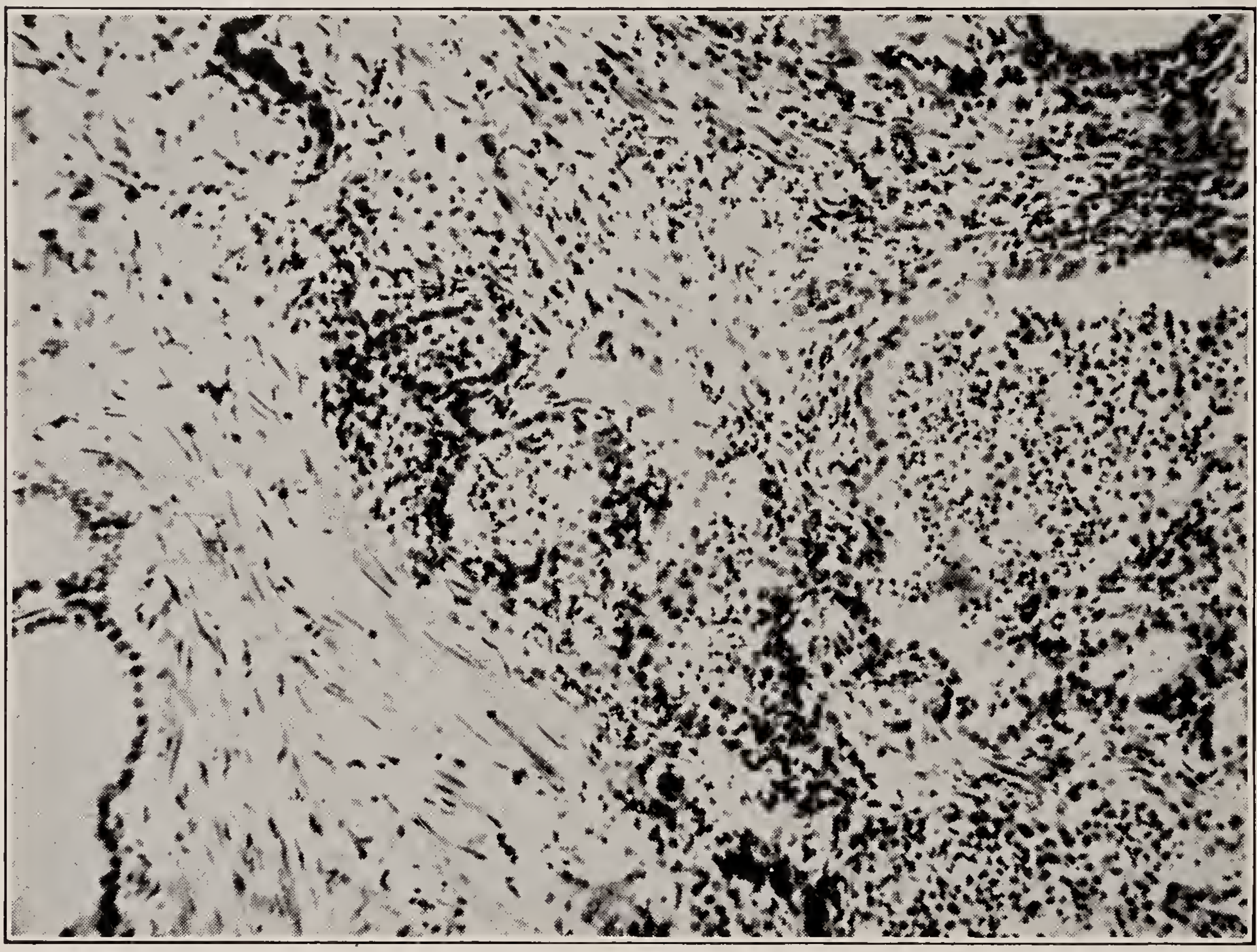

Fig. 22. Photomicrograph of small abscess of the prostate gland. At the left is seen a normal prostatic tubule. To the right of this is an area of fibrosis forming the abscess wall. Beyond this point is an area of leukocytic infiltration, while at the right of the slide is seen the center of the abscess filled with necrotic tissue, leukocytes, and débris.

Diagnosis. Mild prostatitis is likely to escape observation during the course of an acute urethritis. In severe cases, rectal palpation of a symmetrically enlarged, hot, tender gland is sufficient, with the symptoms and the findings of the two-glass urine test, to establish the diagnosis.

Treatment of acute prostatitis. The treatment of acute prostatitis is expectant, and consists of rest in bed for all febrile cases, avoidance of physical strain and sexual excitation in all cases, avoidance of trauma to the gland, sedatives and belladonna and opium suppositories for pain, the application of heat to the prostate; alkalinization of the urine, and forced fluids if there is no urinary retention. Particularly soothing are hot rectal irrigations, which should be given two or three times daily. In the average case, these will result in quick relief of the irritation and swelling. Hot sitz baths are also very helpful. An ordinary bathtub may be partly filled with hot water, in which the patient sits for 15 or 20 minutes, morning and night.

It is most important, in acute prostatitis, to know whether there is residual urine, especially if the patient is having difficulty in voiding, as is usually the case. While the catheter is in the bladder, the latter should be irrigated with an antiseptic solution, such as rivanol dextrose, 1:8,000, acriflavine, 1:8,000, or potassium permanganate solution, 1:10,000 or 1:8,000. The irrigating solution should be given at a temperature of about 105 to 110° F., depending on the tolerance of the individual bladder. Massage of the prostate and urethral instrumentation, aside from necessary catheterization, are contraindicated in the acute stage.

In addition to the above measures for symptomatic relief, chemotherapy — particularly the use of the sulfonamides — has proved useful in shortening the acute stage of prostatic infections (see Nonoperative Treatment of the Prostate Gland: Chemotherapy).

The treatment of prostatic abscess is considered separately.

CHRONIC PROSTATITIS

Etiology and bacteriology. Chronic inflammation of the prostate gland is a very common condition in adult males. In a series of 350 post-mortem studies by the author, a large number of the specimens showed evidence of inflammation of the prostate.

Chronic prostatitis is most often the sequel to an acute infection, which may be caused either by the gonococcus or by other organisms. The incidence of acute prostatitis as a complication of gonorrheal urethritis has been variously estimated at from 50 to 90 per cent.; and untreated acute gonorrheal prostatitis, or incompletely treated posterior urethritis, is undoubtedly the most important factor in the production of chronic prostatitis. It is the author's own observation that after every case of posterior urethritis the prostate is more or less involved, this involvement being manifested by the persistence in the urine of comma-shaped casts of the prostatic-duct orifices, nodulation and induration of the prostate gland itself, and the appearance of more than the usual quantity of pus cells in the prostatic fluid. Only immediately after the inflammation has subsided is the gonoccocus to be found. In a study of 1,000 unselected cases of chronic prostatitis, Kretschmer found gonococci in the prostatic strippings of only 24.

Chronic inflammations are by no means always due to the gonococcus, however. In recent years, with the carrying out of more careful bacteriological studies, many cases of nonspecific chronic prostatitis have been found. The organisms most frequently demonstrated are the colon bacillus and the staphylococcus, streptococcus, and their subforms. Nonspecific and gonorrheal infections are often combined.

Other possible etiological factors in the production of chronic prostatitis are: sexual abuse, instrumental or other traumatism, prostatic calculosis, stricture of the urethra, and certain vitamin deficiencies and endocrine dyscrasias. Any prolonged congestion of the prostate, whatever its cause, will so lower its resistance that an infection is likely to develop.

Signs and symptoms. The signs and symptoms of chronic prostatitis are varied. The most frequent complaints are of pain, a urethral discharge, which may be profuse or merely the so-called " morning drop," and some disturbance of sexual function, always accompanied by neurasthenia. The pain may be local or referred. Ordinarily, it is located in the perineum, and may be described by the patient simply as a " heaviness " in the rectum. With this type, there is usually a history of the passage of prostatic fluid on defecation. The pain may be referred down the back or inner sides of the legs, or into the groins, penis, or sacrum; or it may simulate that produced by renal or ureteral stone.

Frequent and painful urination, urgency, and hesitancy are all common complaints, and result largely from involvement of the posterior urethra and bladder neck. If abscess occurs in the course of a chronic prostatitis, which is not uncommon with nonspecific infections, there will usually be increased leukocytosis and pain, chills, and a rise in temperature.

Frequently the predominant symptoms are metastatic, with absence of local manifestations, so that the prostate is not suspected. The chronically infected prostate is a common focus of infection, and urologists have repeatedly emphasized the importance of examining the gland and its secretion when searching for the source of obscure infectious conditions. We regard the prostate as second only to infected tonsils as a cause of arthritis. It may also be responsible for endocarditis, neuritis, iritis, and myositis.

Diagnosis. The diagnosis of chronic prostatitis is based on (1) rectal palpation, (2) repeated analysis of the voided urine, (3) microscopic examination of the prostatic secretion and ejaculate, and (4) urethroscopic examination of the posterior urethra and vesical neck. It is usually wise to delay this last procedure until the most distressing symptoms have been allayed by treatment (see Nonoperative Treatment of the Prostate Gland: Urethroscopic Examination).

Rectal palpation will often reveal changes in and about the prostate. It will be hard and nodulated, and usually adhesions can be felt extending from its lateral borders to the seminal vesicles and adjacent pelvic tissues. Such a prostate is ordinarily enlarged, and sometimes there are boggy spots between the areas of induration. Areas of normal gland are usually present. It should be emphasized that rectal examination, although of the greatest importance, is not of itself sufficient to establish the diagnosis since not infrequently palpation of the chronically inflamed gland may reveal no gross changes, yet pus cells will be found in the prostatic strippings. A prostate may feel normal, yet function poorly and contain large amounts of pus and débris.

Examination of the urine practically always shows shreds, usually the comma-shaped casts of the prostatic-duct orifices.

Microscopic examination of the prostatic fluid, expressed by massage, is the only reliable method of demonstrating the presence of infection in the gland. Often the diagnosis must rest solely on microscopic evidence of pus in the expressed secretions. Negative findings on one examination are, however, insufficient proof of the absence of prostatitis since pus frequently does not make its appearance until after the prostate has been massaged several times. The secretion expressed by the first massage may be from normal parts of the gland, and two or more manipulations may be necessary to open a pathway into the urethra from a closed-off focus of infection. Massage for diagnostic purposes must be carried out firmly enough to express the secretions, but very gently and cautiously; otherwise epididymitis may result.

The prostatic fluid should be stained at least once in order to determine the presence or absence of bacteria and their nature. Although bacteria are more readily identified on smear than in culture, some of the more chronic cases will fail to show bacteria by either method.

In chronic prostatitis, the prostatic fluid is less opalescent than the normal secretion, and the normal elements are replaced by pus cells and degenerated epithelial cells. The degree of infection is measured by the amount of pus in relation to the lecithin. If there is an equal amount of both present, it is customary to say that the patient has 50 per cent. pus in the prostatic fluid; if there are twice as many lecithin bodies as pus cells, there is said to be 33 per cent. pus present, etc. In well-developed chronic prostatitis, much of the lecithin content of the prostatic fluid will be replaced by pus cells, often in clumps. As the condition improves, the pus cells gradually diminish and the normal elements reappear. In addition to the leukocytes seen microscopically, one notes the presence of red blood cells, degenerated epithelial cells, corpora amylacea, and bacteria. The last may be present in great numbers. The bacteria are usually staphylococci, streptococci, or bacilli of the colon group; less often gonococci, *Bacillus diphtheriæ*, and *Bacillus proteus*.

For securing an uncontaminated specimen of prostatic, or prostatovesicular secretion, the author prefers the following method, which more nearly avoids contamination from the anterior urethra, with its extensive flora of bacteria, than other methods in use: The patient having voided his urine, the penis and meatus are cleansed with green soap and water, and the anterior urethra is irrigated with rivanol dextrose, 1:5,000, acriflavine, 1:5,000, or other antiseptic solution. The patient then kneels on the table, and a small sterile endoscopic tube is inserted to a point beyond the external sphincter into the prostatic urethra. He then bends over and rests on his hands or elbows. The prostate is massaged and each vesicle stripped in turn, and the prostatic urethra finally emptied by several vigorous strokes of the operator's finger down the middle depression of the prostate. The prostatovesicular secretion is received in a sterile test-tube, which the assistant holds at the end of the endoscope. This method may also be used for the separate collection of the secretions from the prostate and each vesicle, care being taken, during massage of the prostate, to avoid the vesicular areas.

The separate secretions from the three organs may also be recovered from the bladder contents, voided immediately after massage and stripping. The patient, having voided his urine, the bladder and urethra are irrigated with rivanol dextrose or acriflavine, 1:5,000 and the bladder filled with the solution. The prostate is massaged thoroughly, care being taken to avoid the vesicular areas. The patient immediately voids — the voided urine containing the prostatic secretion. The bladder and urethra are again irrigated, the bladder is filled with the solution, and the right vesicle stripped. The patient again voids — the voided urine in the second vessel containing the secretion from the right vesicle. The process is repeated for the left vesicle.

Treatment of chronic prostatitis. The patient suffering from long-standing prostatitis is not easily cured, and it is usually advisable to so inform him at the outset of treatment. Symptomatic relief by some form of therapy — especially urethral dilatation, prostatic massage, the application of heat to the rectum, urethrovesical irrigations and instillations, and chemotherapy — is possible in most cases; but reversion to a normal prostatic fluid is more difficult to obtain, and requires the complete removal of infectious foci and the restitution of prostatic drainage.

Restoring the patency of the prostatic ducts is of first importance in the treatment of chronic prostatitis, since retention favors infection. The most effective method of accomplishing this is by a gradual, gentle, but thorough *dilatation of the prostatic urethra* to its maximal capacity. Urethral dilatation should precede massage of the retentive gland, since the latter is beneficial only when drainage can take place through patent ducts. Dilatation is best carried out by means of sounds, the bladder being partly filled with a mild antiseptic solution. Two or three treatments a week should be given until the largest possible sound has been passed on at least three occasions and has remained tight, indicating that the maximal capacity of the urethra has been reached. The voided urine should be examined before each instrumentation, and treatment discontinued whenever the urine becomes cloudy. Should a mild urethritis develop when the occluded ducts resume drainage and empty their infectious contents into the urethra, it may be advisable to employ a urinary antiseptic, such as one of the sulfonamides, mandelic acid, or methenamine.

When satisfactory drainage of the diseased prostate has been restored, *digital massage* may be given once or twice a week upon a bladder partly filled with antiseptic solution. The aims of prostatic massage are (1) the gentle expression of the accumulated secretion, (2) a stimulation of the contraction of smooth muscle fibers, and (3) the stretching and final removal of marginal adhesions. The intelligent application of prostatic massage is beneficial to most patients with chronic prostatitis; but too early, too vigorous, too frequent, or unduly prolonged massage may cause acute epididymitis or other unfavorable reactions. In treating a case of chronic prostatitis, frequent microscopic examination of the unstained prostatic fluid should be made, as the conditions present in the gland, and the results of treatment, can be ascertained in this way much more accurately than by palpation. It has been the author's observation that after massage has been carried out for a long period, the induration may entirely disappear, but the prostatic fluid may remain loaded with pus. After persisting for some time, this condition may suddenly alter, the pus disappearing from the fluid and rapid cure taking place.

The application of heat to the chronically inflamed prostate has definite therapeutic value. Relief may be obtained by hot sitz baths, hot rectal irrigations, or diathermy. Dry heat may be applied directly to the prostate by the Elliott Treatment Regulator, introduced through the rectum.

Hyperpyrexia has been found highly beneficial in certain severe cases of gonorrhea and in the treatment of most gonococcal complications, but it is expensive, very uncomfortable, and attended with considerable risk. Its routine use is, therefore, impractical. Fever therapy should be given only in a hospital and under the continuous supervision of a thoroughly trained personnel.

Vaccines — autogenous and prepared — have been found very helpful in certain cases of arthritis where the infective focus was in the prostate gland, but in other cases their use has resulted in no appreciable benefit. *Intraprostatic injections* of antiseptic solutions have been recommended for recalcitrant pyogenic prostatitis. Our experience has been that the benefits are not sufficient to offset the hazards of this method.

Chemotherapy has assumed an important place in the treatment of chronic prostatitis, especially since the introduction of the sulfonamide group of drugs. This method of treatment, as well as other methods mentioned above, are described in greater detail in the section on Nonoperative Treatment of the Prostate Gland.

General measures include the restriction of physical and sexual activity, and the avoidance of constipation. When there is marked vesical irritation, the patient should be put on a restricted diet, which limits tea and coffee and eliminates spices, alcohol, and certain foods that are irritating to the bladder, such as asparagus, carrots, tomatoes, berries, etc. Adequate vitamin intake is important.

Occasionally a prostate becomes so infected that no amount of treatment by the foregoing methods will effect a cure. Total prostatectomy may then be indicated, if the patient is beyond the age of sexual activity.

PROSTATIC ABSCESS

Etiology. Abscess of the prostate gland may follow failure of an acute diffuse parenchymatous prostatitis to subside or to become chronic — multiple small abscesses in the stroma coalescing to form one large abscess. Our own studies have shown that, in addition to the gonococcus, many other organisms may be present in abscess cavities in the prostate. Since the widespread employment of sulfonamide therapy, gonococcal prostatic abscess — formerly a relatively common complication of specific posterior urethritis and acute prostatitis — is infrequently encountered. Metastatic prostatic abscesses are sometimes a complication of a systemic infection, such as influenza, pneumonia, or typhoid fever; or they may be secondary to a superficial pyogenic infection, such as a carbuncle, furuncle, or felon. In the latter event, the causative organism is the *Staphylococcus aureus.* A metastatic prostatic abscess may develop during the course of any pyemia or septicemia. Occasionally diabetes mellitus is the primary disease. These quite common pyogenic abscesses are usually more serious than gonococcal prostatic abscesses. Some prostatic abscesses are associated with urethral stricture or follow urethral instrumentation. In these cases, an underlying prostatitis is usually present. Others are associated with prostatic hyperplasia or with prostatic carcinoma.

In metastatic prostatic abscess there is frequently no pre-existing prostatitis. An infected embolus lodges in a prostatic vessel, setting up an inflammatory reaction leading to obstruction of the tubules, with resultant formation of a localized abscess. The coalescence of multiple small abscesses results in the formation of a large solitary abscess.

Symptoms. A prostatic abscess usually manifests its presence by pain in the perineum, chills, fever, and frequent and painful urination, which may progress rapidly to strangury and complete retention. Leukocytosis is present. Chronic abscess of the prostate may, however, develop insidiously and persist for weeks without producing local symptoms. There are occasional cases of huge prostatic abscesses in which the only symptom is difficulty of urination, the paucity of symptoms being due to the type and lack of toxicity of the infecting organism. Urinary difficulty and retention in a patient with a history of recent pyogenic infection is suggestive of metastatic abscess of the prostate. Fever and chills are most common with abscesses forming part of a general sepsis, and in such cases there may also be lassitude, malaise, and loss of weight.

Diagnosis. The diagnosis is based chiefly upon the history, rectal palpation, and urethrography. Often the diagnosis is made without difficulty, upon the history and the rectal palpation of an enlarged, asymmetrical, tender gland, with fluctuation. In other cases, however, the symptoms may be few and indefinite; or the suppuration may be submucosal and deep-seated, so that rectal examination is not conclusive. Where the abscess does not drain into the urethra (" closed " abscess), there may be little or no pus in the urine.

If neither fluctuation nor pus is detectible, a urethrogram may establish the diagnosis. Where there is free communication between the abscess and the posterior urethra (" open " abscess), the abscess cavity will usually be outlined by the contrast medium, making diagnosis easy. Deep-seated " closed " prostatic abscesses present greater diagnostic difficulties, and in these cases the urethrogram may prove invaluable. Frequently this will show the posterior urethra to be elongated and narrowed. The pressure of the abscess may cause a more or less S-shaped deformity of the canal, with anterior deflection of the midportion of the posterior urethra and posterior deflection at the vesical orifice. Commonly there is intravesical deflection of the contrast medium, with poor or no visualization of a soft-tissue shadow at the vesical orifice.

Treatment. An untreated prostatic abscess may rupture into the urethra or rectum, or it may burrow into the perineum, bladder, or even the peritoneum, with dire results. Abscesses which empty their entire contents into the urethra are likely to be of the follicular type, or at least not deeply situated in the parenchyma. Spontaneous evacuation through the rectal wall can only be deplored, as a recto-urethral fistula is almost certain to follow, and this may prove highly intractable.

The treatment of prostatic abscess is by incision and drainage, preferably through the perineum (see Operative Treatment of the Prostate Gland). Convalescence is usually satisfactory, although every case must be followed by a period of observation and treatment to insure a normal gland. Chronic prostatitis is present in many of these cases, and this must be treated with prostatic massage, urethral dilatation, the application of heat locally, and sulfonamide therapy.

TUBERCULOSIS OF THE PROSTATE

Etiology. Tuberculosis of the prostate gland is a disease of the young adult, being observed most frequently in the third and fourth decades of life. It is almost always secondary to tuberculosis elsewhere in the genito-urinary tract, and is usually part of a progressive infection that is extending throughout the genital or urogenital system. Walker, in a careful review of the available literature in 1911, made the following summary of the incidence of secondary involvement: "Simmonds reports 35 cases of genito-urinary tuberculosis in which the prostate was involved 26 times. Oppenheim, in 27 cases, found 19 with prostatic tuberculosis; Collenet, in 70 cases, found it 44 times. Krzywicki, in 15 cases of genito-urinary tuberculosis, found 14 involvements of the gland. Halle and Motz, in 72 cases of genital tuberculosis, found 59 showing lesions of the prostate."

Primary tuberculosis of the prostate appears to be very rare. Saxtorph, in 10,016 autopsies at Copenhagen, found records of 547 cases of genito-urinary tuberculosis, with isolated tuberculosis of the prostate being found 9 times. Walker reviewed a large number of supposedly primary cases, but rejected the majority because there were no cystoscopic examinations excluding vesical tuberculosis, and also because the authors assumed that the focus most advanced in appearance must of necessity be the primary or oldest one, which is by no means the case. He admitted, however, that primary involvement of the prostate does occur. Carefully verified cases of primary tuberculosis of the prostate have been published by Crandon, Koll, Barney, Scott, and Strom. In Crandon's case — an undoubted instance of a primary and isolated prostatic tuberculosis — a tuberculous mass was found in the prostate at autopsy, with no other evidence of tuberculosis in the body. The complete autopsy record published by Scott is of especial interest because of the advanced age of the patient and the difficulties in diagnosis which were encountered. Even today, it is probable that the possibility of tuberculous invasion of the prostate is often overlooked in patients who are beyond the age usually associated with urogenital tuberculosis, and who are passing through the age period when benign hypertrophy and malignancy of the prostate are common. Scott remarks that " the differential diagnosis between early carcinoma and old fibrous tuberculous nodules of the prostate in men of cancer age is especially difficult, in fact so difficult that the presence of the latter condition is often first realized when the pathologist renders his report. Therefore,

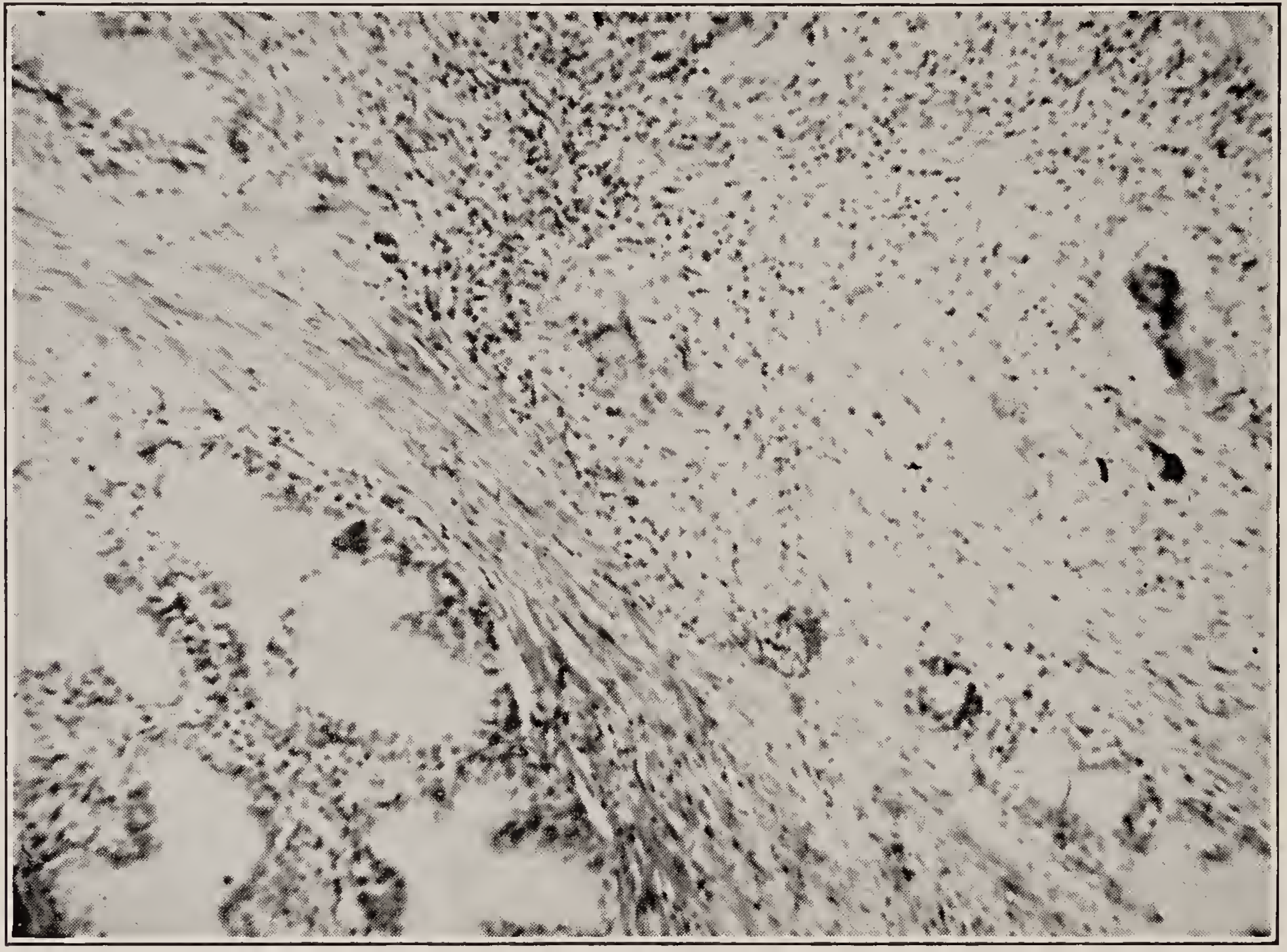

FIG. 23. Photomicrograph of section through a tuberculous prostate, showing several giant cells and the usual wall of mononuclear cells. In the lower left-hand corner of the slide is a normal tubule.

in cases that present the slightest findings which are not in keeping with those of outspoken carcinoma of the prostate, a careful study should be made with the idea of ruling out, if possible, a tuberculous condition."

Tuberculosis of the prostate is most commonly found in association with tuberculous infections of the epididymes, vasa deferentia, and seminal vesicles — less often as an accompaniment of urinary tuberculosis. Various observers place the incidence of prostatic involvement at from 50 to 70 per cent. of all cases of tuberculosis of the male genital tract. The relative frequency of such involvement is readily understood when one considers the position of the prostate at the junction of the urinary and genital tracts. It is obvious, therefore, that when tuberculosis of the urogenital tract is discovered, a careful examination of the prostate should always be made, even though there may be no symptoms pointing to the gland.

Infection may reach the prostate (1) by way of the blood stream, (2) by direct extension, (3) by the lymphatics, or (4) by infected urine.

Pathology. In the relatively numerous cases where the prostatic lesions are an extension from a tuberculous seminal vesicle, the prostatic lesion may at first be confined to the region about the ejaculatory duct on the side corresponding to the infected vesicle, whence it spreads, by way of the acini or by the lymphatics, to other portions of the gland. Occasionally the epididymis, vas deferens, seminal vesicle, and perhaps the kidney on one side will be tuberculous, and the organs of the opposite side free of disease. One may then find tuberculous nodules and even abscess formation on the corresponding side of the prostate gland, and the other side partially or entirely free of disease. In the rare cases in which the prostate is infected by tubercle bacilli conveyed in the urine, the initial lesion is periurethral. This immunity of the gland to infection in many cases of renal and vesical tuberculosis is indeed surprising since the posterior urethra and the prostatic-duct orifices are constantly bathed in infected urine, sometimes over a period of many years.

The first pathological change is the formation of tubercles. Other tubercles develop from these original foci and extend in the usual manner, the bacilli usually being observable at the borders of the tubercles. Later stages are fibrosis, caseation, and suppuration. A tuberculous abscess may rupture through the prostatic capsule, with the formation of a very intractable perineal fistula; or there may be rupture into the urethra. Spontaneous healing is rare but occasionally does occur. Small caseous areas may suppurate and discharge into the urethra, later healing by cicatrization; or they may become encapsulated or latent; or they may undergo calcification and encapsulation.

Symptoms and diagnosis. With well walled-off tubercles, there may be no symptoms whatsoever. If the tubercles have coalesced to form an abscess, which has finally ruptured into the urethra, there will be frequency, dysuria, hematuria, and pyuria. The secretion may show tubercle bacilli.

Rectal examination reveals a nodular, elastic gland, usually affected on one side only. Although the tuberculous prostate as a rule differs from a carcinomatous condition in that it lacks the boardlike consistency commonly associated with the latter, it may sometimes be very difficult, as has already been pointed out, to differentiate between early carcinoma and old fibrous nodules of the prostate in men of cancer age. The differential diagnosis is based chiefly on microscopic study of a specimen of diseased tissue.

Treatment. Surgery is applicable only to relatively few cases of tuberculosis of the prostate gland. When calcium deposits are present, total prostatectomy is indicated. On the other hand, operation is distinctly contraindicated in acute and subacute tuberculosis. Even in the presence of abscess, it is preferable to allow it to absorb or rupture into the urethra rather than to evacuate it through the perineum, as the latter procedure is likely to leave a persistent fistula. Radical removal of the genital tract, which is occasionally justified in selected cases of tuberculous involvement of the epididymis, vas deferens, and seminal vesicle on one or both sides, is not advisable in patients with extensive involvement of the prostate gland.

Since prostatic tuberculosis is usually part of a generalized genital or urogenital tuberculosis, we generally put these patients on the hygienic, dietary, and therapeutic regime advocated for postoperative and inoperable tuberculosis of the genito-urinary tract, and good results have been obtained therefrom in some cases. In the author's service, these patients are treated in a special clinic, which is in the charge of Dr. Stanley L. Wang. The plan of treatment is based on the recognition that urogenital tuberculosis is a local manifestion of a systemic disease, and is administered along two lines: (1) the urological, and (2) the constitutional.

The urological treatment depends upon the location and nature of the urological lesions in the genito-urinary tract, and includes (as indicated) renal pelvic lavage, ureteral dilatations, bladder irrigations and bladder instillations of novocaine borate, 2 per cent., or oil of cajeput or gomenol, 2 per cent. in olive oil, fulguration of bladder ulcers, prostatic and seminal vesicular treatments, and additional surgical measures as required.

The constitutional treatment consists of rest, fresh air, medicinal therapy, old tuberculin, a special dietary regimen, heliotherapy, and quartz-light irradiation, both externally and intravesically (Nonoperative Treatment: Quartz-Light Therapy). The patient is given detailed instructions regarding rest, exercise, fresh air, and diet. Careful selection of foods, omitting those that are irritating to the diseased urinary tract, has proved decidedly beneficial to many patients with bladder involvement. A modified high alkaline ash diet is useful as a starting-point, continuing or changing it with the *p*H of the urine as a guide. Internal drugs include viosterol, haliver oil and viosterol, and cod-liver oil, methylene blue for burning on urination, and, for irritable bladder, Kirwin's Mixture (see Nonoperative Treatment: Chemotherapy). Heliotherapy is beneficial in all cases of genito-urinary tuberculosis without active pulmonary lesions, but in urban communities there are definite limitations to its employment. Whenever possible, patients are advised to take sun treatments on the days of the week when they do not receive the lamp exposures, and are given exact instructions regarding the duration and extent of the exposures.

Dr. Wang has found, after many years of observation, that patients suffering from urogenital tuberculosis (in whom there are no demonstrable lung lesions), who are treated with gradually increased doses of Koch's old tuberculin, do much better than those who live under the same excellent hygienic conditions without receiving the injections. The tuberculin is diluted with a diluent of 0.6 of 1 per cent. sodium chloride, to which is added 0.25 of 1 per cent. phenol. The dilutions are extended to 1 to 10 millions. Treatment is begun with 0.1 to 1 cc. of the 1 to 10-million dilution, given hypodermically twice each week. The dose is increased 0.1 of 1 cc. each dose until a local, focal, or general reaction ensues. When this occurs, the dosage is reduced to the starting-point of 0.1 to 1 cc. of the 1 to 10-million dilution and begun all over again.

SYPHILIS OF THE PROSTATE

Incidence. Syphilis of the prostate gland is apparently very rare, to judge by the few reports in the literature and the lack of information upon the subject in standard text-books. Just why the prostate, which seems to be peculiarly susceptible to other types of infection, should be almost immune to such an ubiquitous disease is a question not without interest. In 1920, Lloyd Thompson thoroughly reviewed the literature upon the subject and found but 24 recorded cases, 12 of which he considered doubtful. Only a very few cases have been reported since, bearing out Thompson's assertion that the condition is either very rare or frequently overlooked. In all but a handful of the reported cases the diagnosis was based purely on clinical grounds.

Pathology. Warthin, in 1918, was the first to report a case of prostatic syphilis in which the diagnosis was based upon the presence of typical syphilitic changes in the prostate, with the finding of *Spirocheta pallida* in the lesions. This pathological description of a syphilitic prostate is contained in the report of a post-mortem examination upon the body of a young man with early tertiary syphilis clinically latent. Warthin found the prostatic lesions to be similar to syphilitic lesions in other organs. Diffuse plasma-cell infiltrations occurred throughout the stroma of the organ, and not around the gland spaces as in chronic gonorrhea. The infiltrations were perivascular, interstitial, and not periglandular or subepithelial. Fibroblastic and angioblastic proliferations were prominent, and numerous giant cells occurred in the larger infiltrations, giving them the character of miliary gummas without caseation. Groups of spirochetes were found in these.

Starry, in 1924, gave a good microscopic description of a syphilitic prostate removed from a man aged 73 years in the belief that the condition was one of simple hypertrophy. He states that the prostate may show all stages of syphilis, in varying degrees, from the early miliary gumma to the old healed, scarred lesion. His description is essentially similar to Warthin's. There was practically no subepithelial infiltration about the glands, as is often seen in chronic gonococcal prostatitis, and no tendency to caseation. Stained sections showed a few spirochetes in the more active lesions. In the region of the prostatic urethra, areas of cellular infiltration occurred; these were invariably deep and not subepithelial.

The chief feature of the gross pathology is enlargement, which always occurs and may be unilateral or bilateral. Hardness and nodulation are also common findings. The gland may or may not be tender on palpation.

Symptoms and diagnosis. The most common symptoms are pain and urinary frequency, difficulty, and retention. The pain is usually located in the perineum, but may radiate to the legs or penis. It may be slight or very severe; and is sometimes independent of, but in most cases is aggravated by, urination. Occasional manifestations are hematuria and pain on defecation or coitus. The urine is usually cloudy and on examination shows albumin, pus, and blood. On rectal palpation, the prostate will generally be found enlarged, irregular in contour and consistency, and sometimes nodular. Occasionally, however, it may be smooth or elastic. Cystoscopically, the most common findings are lateral-lobe enlargement and irregularity, with edema and sometimes thickening of the vesical neck and trigone. The Wassermann test is usually positive.

Prostatic syphilis is a late manifestation of lues, and occurs, as a rule, between the ages of 40 and 70 years. Because of this age incidence, as well as the similarity in the rectal and cystoscopic findings, malignancy is frequently suspected and the diagnosis of syphilis rarely made unless the patient gives a history of specific infection or shows other evidences of syphilis. The condition must also be differentiated from simple hypertrophy, which is common in this age period and is attended by similar symptoms.

Treatment. The treatment consists of the usual antisyphilitic measures, reinforced by surgical drainage of necrotic gummas. In all of the reported cases treated by specific therapy there was rapid relief of the symptoms, rectal examination showing marked reduction in the size and irregularity of the gland. In some, the symptoms cleared up completely and the prostate became entirely normal.

CYSTS OF THE PROSTATE GLAND

Etiology. Cysts of the prostate gland, of a size sufficient to produce symptoms, are rare. Emmett and Braasch, reviewing the literature in 1936, collected 54 cases.

By far the most common is the simple retention cyst, which may arise in any portion of the prostate proper, as well as from the subtrigonal group of glands. This type of cyst is merely a normal acinus the outlet of which has become occluded, causing expansion of the acinus, with thinning out of its simple columnar epithelium and retention of secretion. If the cyst is so situated that it projects into the urethral lumen or bladder, it will be covered externally with the mucous membrane of the urethra or bladder. Retention cysts may also be formed by the coalescence of several dilated acini.

Other acquired cysts of the prostate are echinococcus cysts, bilharzial cysts, cystic adenomas arising from mucous glands (all of which are very rare), and the cysts associated with carcinoma of the prostate. These last seldom reach a size permitting clinical recognition.

Often described with cysts of the prostate gland are congenital unilocular cysts of the prostatic utricle, and cysts in the connective tissue situated between the prostate and the anterior wall of the rectum. These congenital cysts are believed to be the result of anomalies such as failure of the müllerian ducts and woffian bodies to undergo atrophy.

Symptoms and diagnosis. A cyst of the prostate, unless it is so located or of such a size as to cause obstruction or pressure, may remain undiscovered throughout life. Small cysts between the prostate and rectum may give rise to no symptoms; larger cysts in this region may interfere with defecation. Prostatic cysts which project into the posterior urethra or bladder neck give rise to symptoms of prostatism, namely urinary frequency and urgency, nocturia, painful micturition, a slow, interrupted stream, and residual urine. Sometimes there is hematuria. If the cyst is of a size to produce tension in the prostatic capsule, there will be perineal or urethral pain.

Prostatic cysts that project into the posterior urethra or bladder are readily diagnosed cystoscopically. They must be differentiated from the multiple smaller, inflammatory excrescences and lymphocystic lesions often found in the prostatic urethra and vesical orifice in chronic urethritis. Cysts that are situated deep in the prostate or near its posterior surface must be diagnosed by rectal examination.

Treatment. Smaller, asymptomatic retention cysts that are discovered accidentally are best left alone. Cysts that are discovered cystoscopically can usually be destroyed by fulguration through the urethroscope or removed by prostatic-resection instruments, and this is the treatment of choice. Simple puncture may result in the relief of symptoms, but the cyst usually refills quickly. Only complete destruction or removal of the cyst wall is curative. Large cysts in inaccessible locations may require suprapubic or perineal operation.

BENIGN HYPERPLASIA OF THE PROSTATE GLAND

Definition. Benign hyperplasia (long known as benign " hypertrophy ") of the prostate is a pathological overgrowth of portions of the gland, of indefinite etiology but of great clinical importance since it results in more or less obstruction to urination, with secondary changes in the bladder and upper urinary tract due to back pressure and secondary infection. It occurs in from one-third to one-fifth of all men over 50 years of age. The lobes most frequently affected are the median and lateral, the anterior lobe being affected rarely, and the posterior — the most frequent site of primary prostatic carcinoma — practically never.

Etiology. The prostate gland, like all other glands, should normally atrophy in elderly persons. Numerous theories have been advanced to account for the tendency of the gland to enlarge with age. The more important are: (1) that the condition is a cystic glandular hyperplasia having its basis in infection of long standing and more particularly involving the urethral portion of the gland; (2) that the enlargement has an arteriosclerotic basis; (3) that it is due to true tumor formation which takes its origin, according to some, from the suburethral or subtrigonal accessory glands, or, according to others, from any part of the prostate gland proper; (4) that it is a fibroepithelial growth akin to myoma of the uterus; (5) that the hyperplasia is endocrinopathic, and due to an improper balance between the male and female hormones in favor of the latter.

The inflammatory theory still has its advocates. Infection is a frequent finding in cases of benign prostatic enlargement, and microscopic study of many prostates shows round-cell infiltration and evidence of inflammation. On the other hand, many surgical specimens fail to show any signs of inflammation; and it is well known that men with histories of prolonged infection in middle life are apparently less apt to develop prostatic hyperplasia than individuals who have had no such infection.

Virchow (1863) and, beginning with Albarran, the majority of

French investigators — Motz and Perearnau, Marion, Marquis, Chevassu — as well as many others, hold that benign prostatic enlargement is due to true tumor formation, their only difference of opinion being as to whether these tumors take their origin from the suburethral glands of the prostatic urethra (Albarran), or whether they may arise from any part of the prostate gland (Marion). Tandler and Zuckerkandl (1912), after a minute study of sections from 42 prostates obtained at autopsy or operation, observed that hypertrophy of the entire gland never takes place. They contended that the process always begins in the median lobe

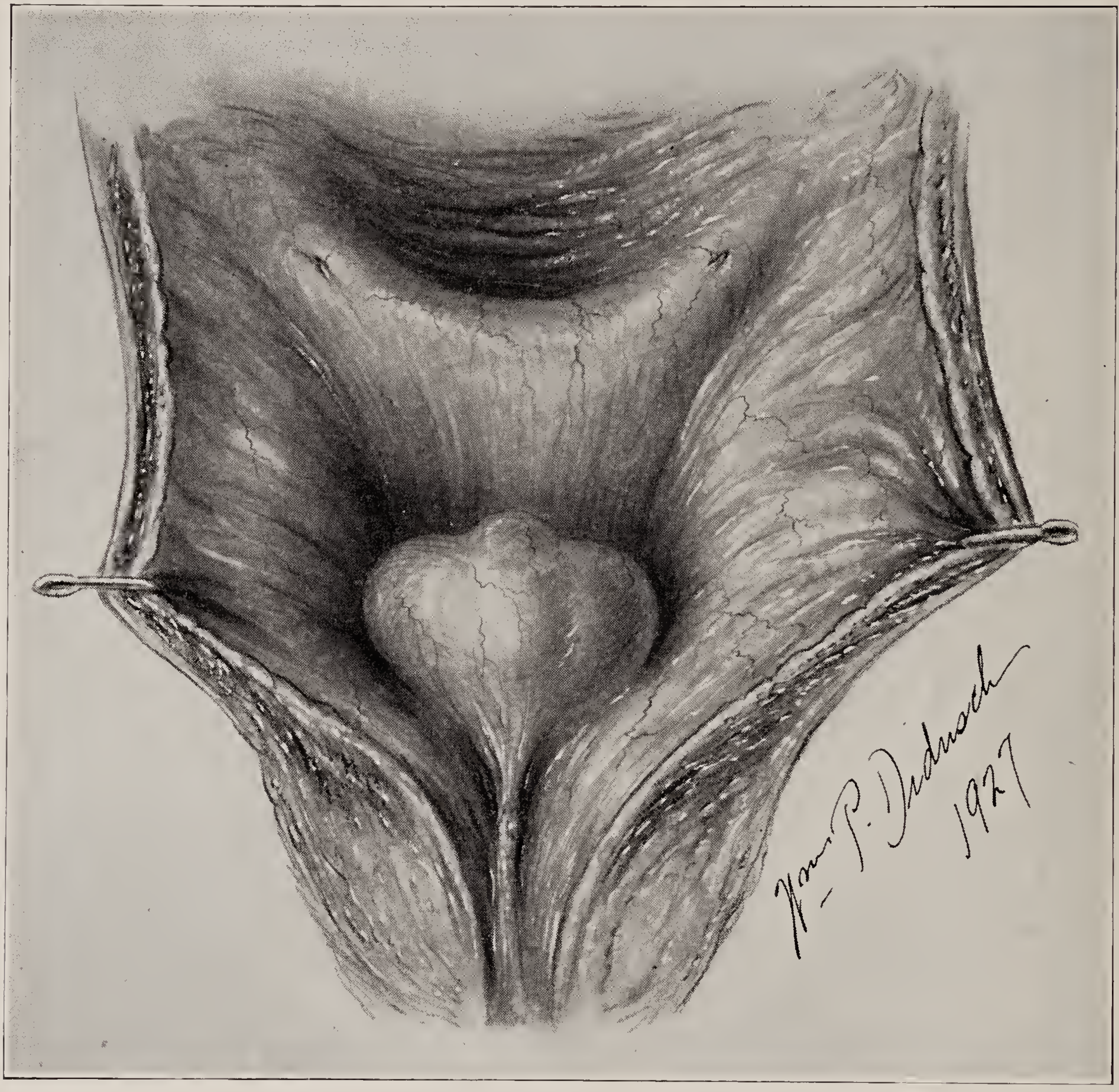

Fig. 24. Subcervical group enlargement, with marked elevation and hypertrophy of the vesical trigone, which is usually an accompaniment of obstruction to urination. (From the collection of Prof. Legueu.)

which, as it enlarges, encroaches upon and compresses the other portions of the gland. Simond's theory is that the subepithelial or suburethral glands are the structures which actually undergo hypertrophy, and that the prostate gland proper undergoes presenile changes similar in character to those observed in other organs with the advance of age. It has been the author's observation that the subcervical tubules are enlarged in almost 25 per cent. of men over 30 years of age, and that this may occur without any enlarge-

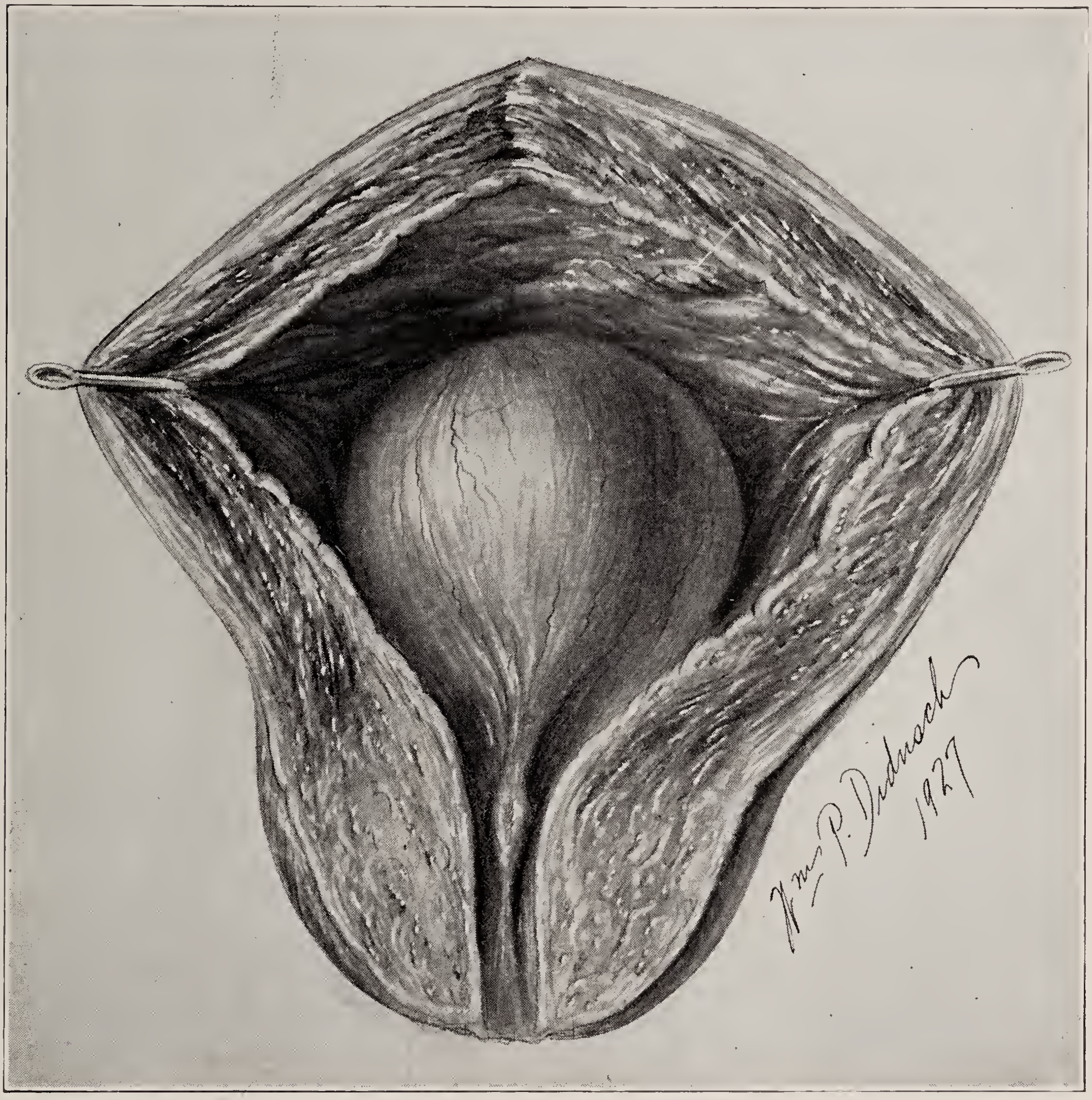

Fig. 25. Showing the tremendous size to which the subcervical group of tubules may enlarge. Here it entirely covers the vesical trigone. (Specimen from the collection of Prof. Legueu at Hôpital Necker, Paris.)

ment of the prostate. However, when the prostate gland proper is enlarged, the subcervical group will also show overgrowth. If a portion of the gland intrudes into the bladder, it will usually be found to be the subcervical group of tubules. These can be identified microscopically by the slight tendency of the mucosa to become heaped up and to project into the lumina of the tubules, which are lined with many layers of cuboidal epithelium instead of a single layer of columnar epithelium such as forms the lining of the prostatic tubules. A further point of identification is the absence of the muscular envelop found in the prostate proper. Frequently the subcervical group will be found embedded in the median lobe.

Practically all present-day students of benign prostatic enlargement agree that the overgrowth makes its first appearance near the prostatic urethra and just under the mucosa; but just which component or components of the prostate — glandular, muscular, or fibrous — gives rise to the hyperplasia is a much-discussed question.

For over a century it has been known that solid fibromuscular masses and glandular masses coexist in specimens of so-called prostatic hypertrophy. Velpeau, in 1841, recognized fibromuscular masses. Thompson, in 1873, also found them, and thought that, microscopically, they resembled the myomas of the uterus, an opinion also held by Reischauer. Patch and Rea found leiomyomatous nodules in 25 per cent. of 181 consecutive surgical specimens. Until fairly recently, however, the importance of these fibromuscular masses was largely overlooked, due chiefly to the fact that microscopic sections of surgical specimens have shown a preponderance of glandular tissue, with varying amounts of muscle and fibrous tissue, so that it was natural to assume that the enlargement is an overgrowth of glandular tissue which closely resembles the glandular tissue of the normal prostate. Recognition of the significance of these fibromuscular nodules has been stimulated of late by the studies of Dr. Clyde L. Deming and the etiological theory of prostatic enlargement suggested by him.

Deming contends that so-called adenoma of the prostate is not an hypertrophy of existing prostatic or periurethral accessory glands, but is, in reality, composed of newly formed glandular elements from the *ducts* of the prostatic glands. He further contends that the overgrowth does not arise directly from the suburethral prostatic glands but has its origin well within the muscular wall of the prostatic urethra, in solid fibromuscular masses which stimulate epithelial hyperplasia from the adjacent ducts of the prostatic glands. Invasion of the solid fibromuscular masses by the hyperplastic ductal epithelium converts the nodules into glands similar in appearance to the glands in the normal prostate.

Deming's conclusions are based on a study of the early phases of the development of benign prostatic overgrowth by the examination of serial sections of prostate glands removed at autopsy from subjects 45 years of age and upward, only microscopic nodules being utilized. Fibromuscular masses in the muscular wall of the posterior urethra, anywhere between the verumontanum and the internal vesical sphincter, were found to constitute the primary lesion, from 1 to 16 of these masses being seen in a single specimen. They are most frequently found near the verumontanum and in the floor of the urethra; are fairly common in the lateral walls; but are rarely observed in the muscular roof of the urethra, and never in the capsule, lateral lobes, or posterior lobe of the prostate gland.

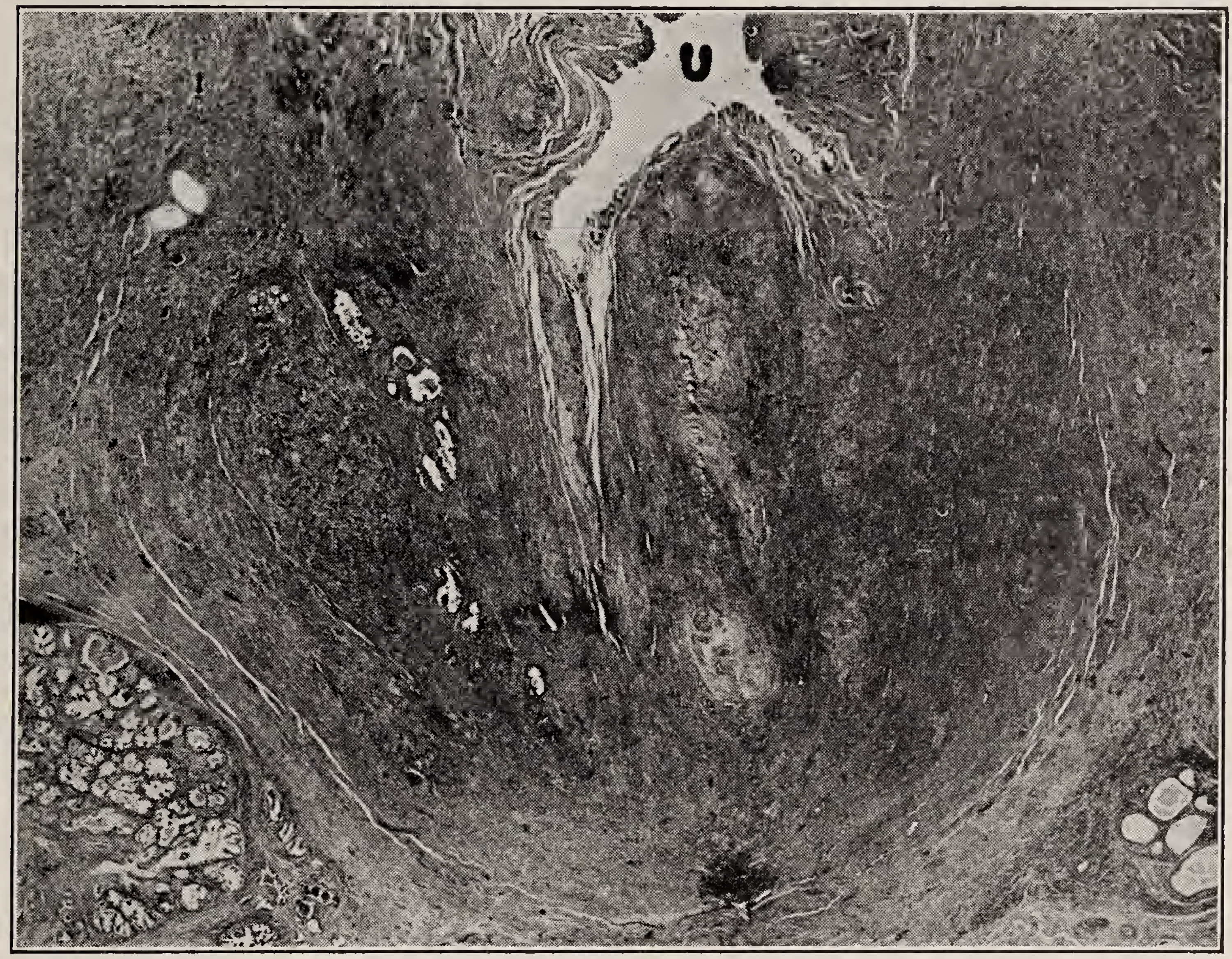

Fig. 26. Cross section of prostate of man 72 years old, showing muscular wall of urethral floor with several light areas which represent early fibromuscular nodules. U., Urethra. Autopsy specimen. Photomicrograph X 125. (Deming.)

These masses lie parallel to the muscle fibers of the urethral wall *between* and at right angles to the prostatic ducts. (Near the verumontanum the muscular wall of the urethra is pierced by large numbers of ducts and some glands.) The fibromuscular hyperplasia begins around a blood vessel. "As the nodules enlarge, they are enriched and nourished with newly formed vessels. As they increase in size, they become encapsulated. When stained with hematoxylin and eosin and Masson stains, they show the same muscle arrangement and color as the myomas of the uterus, and are devoid of glands."

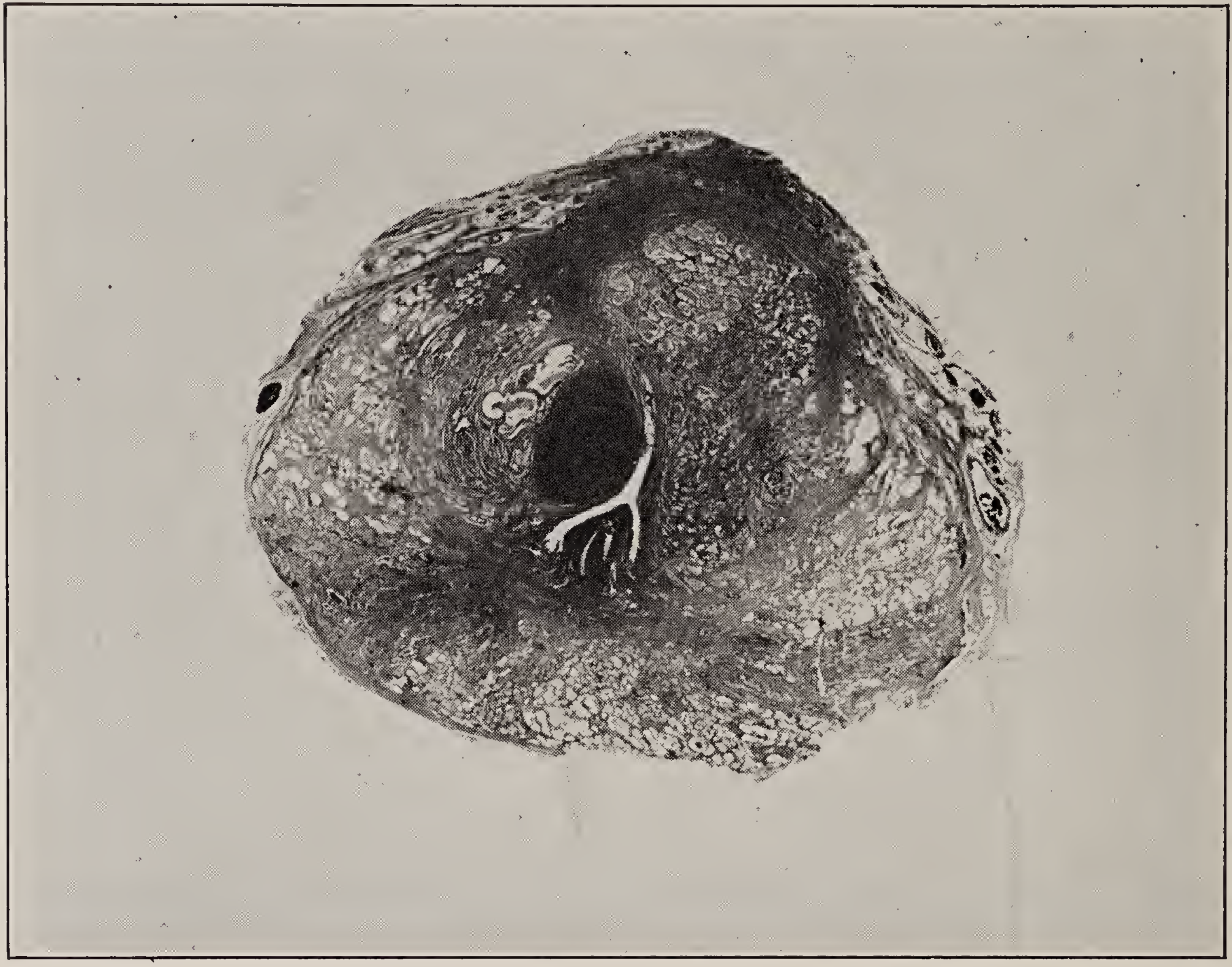

FIG. 27. Cross section of prostate of man 68 years old, showing fibromuscular nodule in the muscle wall of the urethra and, in the opposite muscular wall, a large asymmetrical glandular mass. Autopsy specimen. Photomicrograph X 1½. (Deming.)

The secondary phase in the development of the benign overgrowth is the invasion of the solid fibromuscular mass by the epithelium of a duct or gland which lies adjacent to the nodule. Some inherent quality of the nodule seems to stimulate buds of epithelium in the duct to invade the nodule, and it is from these epithelial buds that the glandular tissue is formed. Since the glandular tissue grows much more rapidly than the primary fibromuscular tissue, the latter may be entirely invaded, with the result that the fully developed surgical specimen may appear wholly glandular. The glandular nodules, like the fibromuscular masses, are found in the muscular wall of the urethra in the early phases, and are not found in the true lateral and posterior lobes of the prostate. As they increase in size, they gradually deflect the prostatic urethra, compress the true lateral and posterior lobes toward the capsule, and assume the position of the lateral lobes on each side of the urethra. When the primary fibromuscular nodule lies at too great a distance from a duct or gland to stimulate epithelial proliferation, it remains aglandular. Occasionally it may develop into a large leiomyomatous mass sufficient in size to cause obstruction to the bladder.

Deming states that the primary fibromuscular nodule closely resembles the uterine myoma in its appearance, muscle arrangement, and staining qualities, and thinks that it is reasonable to assume that since the uterine myoma is derived from a muscle cell, the primary prostatic nodule also may have its origin in a muscle cell of the lower müllerian-duct system. He points out that the fibromuscular nodules appear in greatest numbers near the verumontanum, and the utriculus masculinus — the homologue of the uterus — is derived embryologically from the müllerian-duct system. Support is lent to this theory by the present author's own studies of the embryology of the prostate, in which it was found that the muscle fibers of the müllerian-duct system pierce the posterior urethra near the verumontanum, where they mingle with the muscle fibers of the urethra.

A theory that during the past decade has received an enormous amount of study both here and abroad, but is as yet too incompletely understood to be intelligently discussed here, is that prostatic hyperplasia in advancing years is due to endocrine imbalance. With the growing knowledge of the various hormones that may affect the secondary sex organs (the male sex, female sex, anterior pituitary gonadotropic factor, etc.), and the interrelationship of these hormones, new ideas have arisen regarding the etiology and treatment of benign prostatic enlargement. That there is a direct relationship between the testis and the prostate has been known since the days of John Hunter, when it was recognized that castration of the normal adult causes atrophy of the prostate. Later it was observed that eunuchs and postoperative castrates were not afflicted with prostatic enlargement, which led some surgeons to advocate castration and vasectomy to effect shrinkage of the enlarged prostate, although no satisfactory explanation of the mechanism was ever produced. J. W. White, writing in the last decade of the nineteenth century, summarized the results in 111 cases of prostatic hypertrophy treated by castration, and stated that in about 87 per cent. "rapid atrophy of the prostatic enlargement" followed the operation. Castration, as a treatment of prostatic hypertrophy, became obsolete at the turn of the century.

In 1923, the investigations of Lower and McCullagh concerning the relationship of the ductless glands to prostatic enlargement created a renewed interest in the subject and spurred on animal experiments and biochemical researches that laid the foundation for male hormone therapy. The interrelationship between the prostate, the testes, and the anterior pituitary gland is now clearly recognized. We know that following castration the prostate and seminal vesicles atrophy, and that similar effects follow hypophysectomy.

Experiments conducted by Lower, McCullagh, Walsh, Moore, Cutler, and DeJongh all tend to confirm the belief that the testicle produces two hormones. Androtin, the male sex hormone, is produced by the interstitial cells and controls the development and maintenance of the secondary sex glands, of which the prostate is the most important. Its production is regulated by the anterior pituitary. It has been repeatedly demonstrated that hyperfunction of the pituitary gland can stimulate the testes to the production of enough androtin to cause enlargement of the prostate. The second testicular hormone (inhibin, contruin) has not yet been isolated but is believed to be formed by the germinal cells and to act as a control to the pituitary gland. Normally the germinal cells are supposed to secrete enough of this substance to prevent excessive secretion of the pituitary hormone; but with degenerative changes or decreased function of the germinal cells, as in old age, the amount would supposedly be so reduced that the functional ability of the pituitary gland would be unrestricted. The theory of Lower and his associates is that absence of inhibin leads to pituitary hyperactivity, which, in turn, stimulates the production of androtin and produces prostatic hyperplasia.

It has also been suggested that hyperplasia of the prostate may be due to a lack of balance between the androgenic and estrogenic substances in the male. In a normal male under the "prostatic age," the male and female sex hormones are supposedly in balance with each other and with the hormones of the pituitary and adrenals. The estrogens have an inhibitory effect on the anterior pituitary. Benign hyperplasia, according to the view of Laqueur and his associates, of Amsterdam, is due to a deficiency of the male hormone, resulting in improper inhibition of the hyperplastic action of the estrogenic and other gonadotropic substances. Hence, administration of testicular hormone should restore the hormone balance, but the results of such therapy to date cast grave doubts on its ability to stop or even inhibit the hyperplastic process once it has begun.

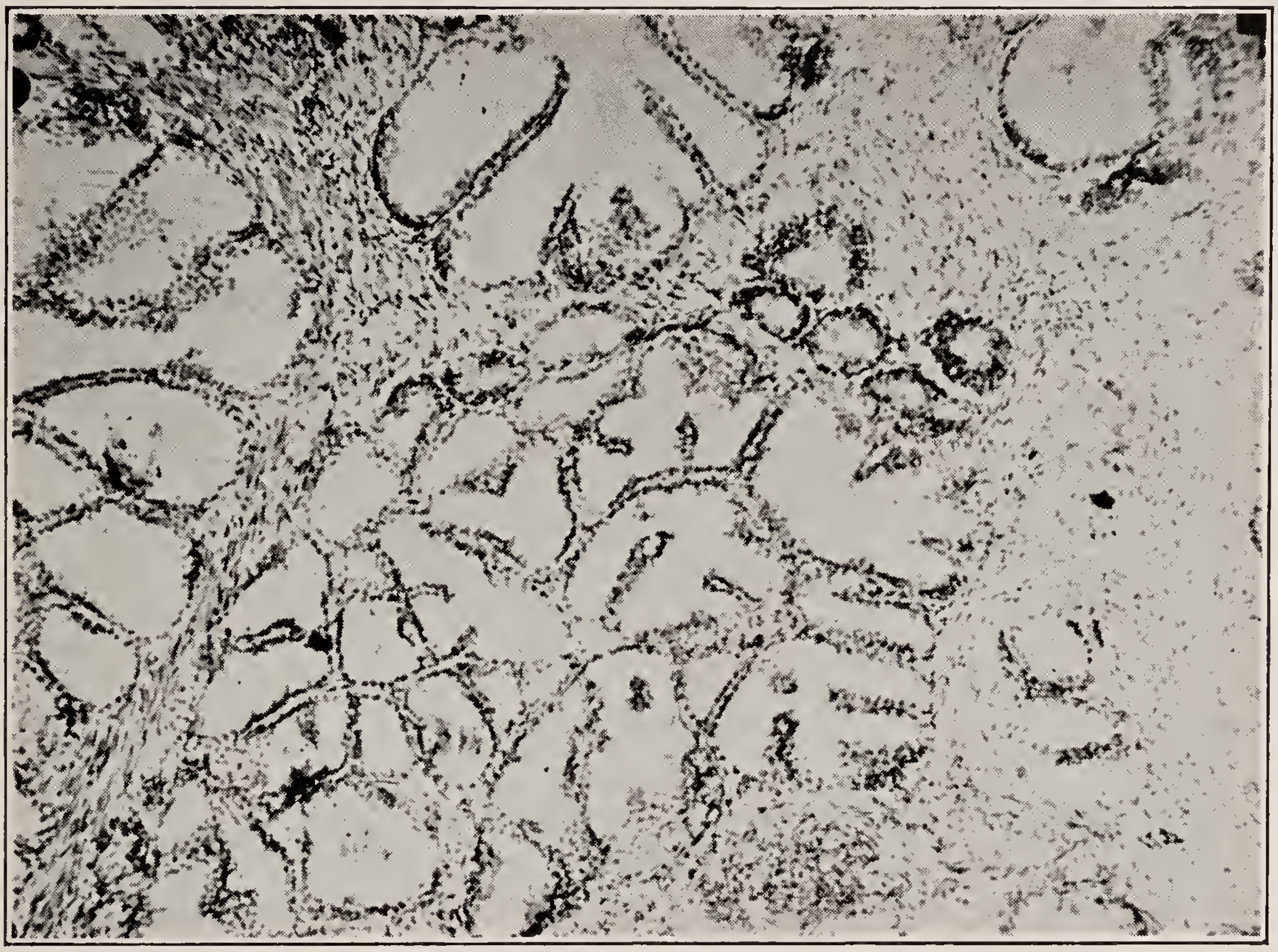

FIG. 28. Photomicrograph showing the ordinary adenomatous type of prostatic enlargement under low power. Distention of the tubules with fluid has resulted in a reduction of the intertubular tissue to a minimum, producing the so-called "bridging" effect.

Wugmeister, in 1937, expressed the view that benign hyperplasia of the prostate is due to a deficiency of the estrone normally present in males. Treatment of a series of 23 patients with large doses of estrone resulted in marked functional improvement and a decrease in the size of the prostate. Recent reports by a number of workers on the results of treatment of prostatic hyperplasia by means of other estrogenic substances, notably diethylstilbestrol and diethylstilbestrol dipropionate, claim good results from their use and encourage the hope that estrogenic therapy may prove more efficient in the control of this lesion than has the use of androgenic substances.

Obviously, much work must still be done before the question of whether or not hyperplasia of the prostate is under endocrine control can be answered.

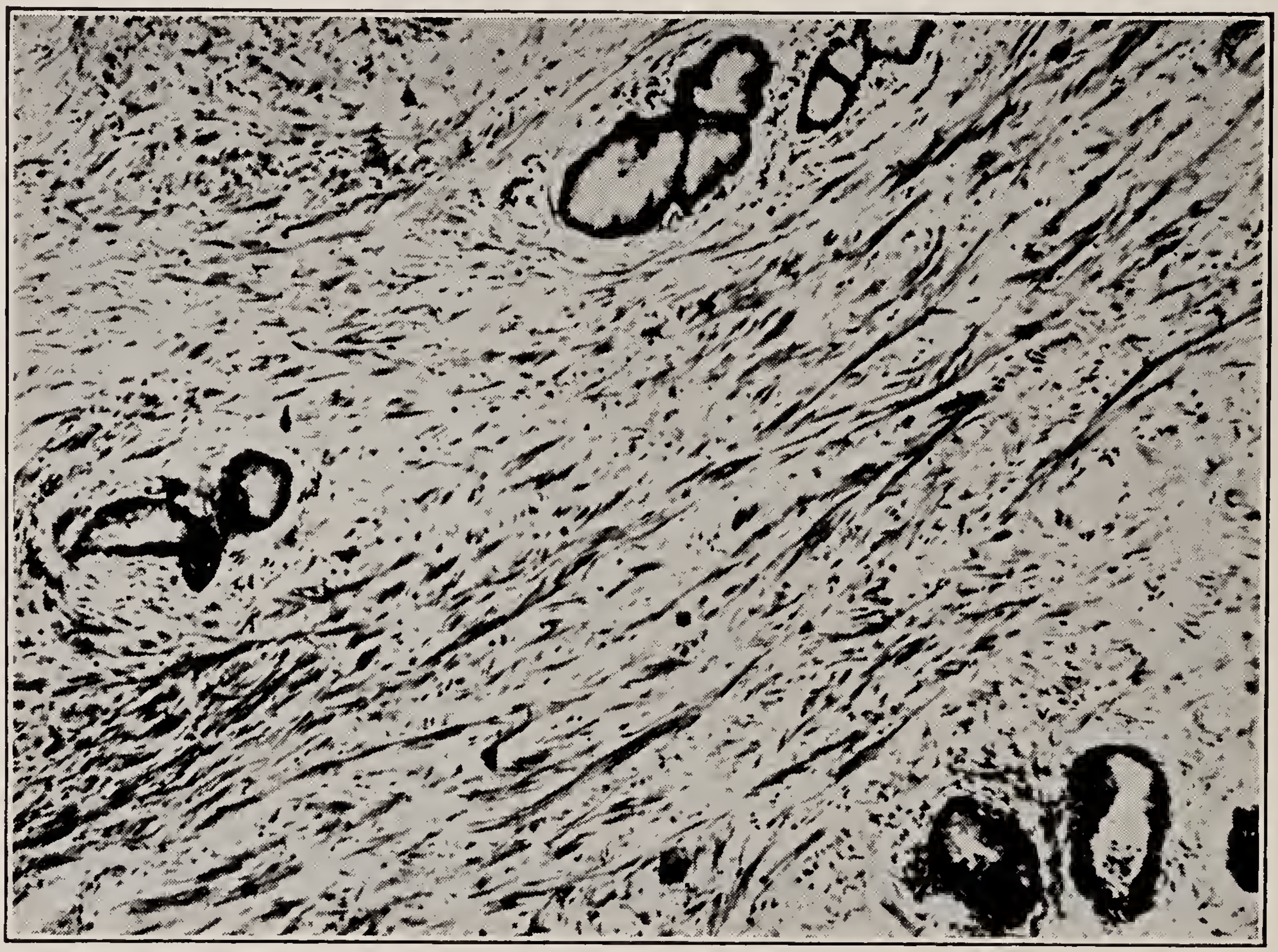

Fig. 29. Photomicrograph of a section showing the fibrous type of prostatic hypertrophy. The groups of tubules are surrounded by large areas of dense fibrous tissue, which have a characteristic leathery feel to the palpating finger, in contradistinction to the boardlike induration of carcinoma of the prostate gland.

Pathology. Microscopically, four types of benign enlargement of the prostate may be distinguished. The most common type is the *glandular*, which is characterized by dilatation of the tubules with fluid. The tubules are lined with a single layer of tall cylindrical cells with their nuclei near their bases. Usually the lumina show an intrusion of the mucous membrane in the form of papillary projections due to proliferation of the mucosa. Frequently the lumina are so distended, and the amount of interstitial tissue between the tubules is so decreased, that the epithelial cells will be found on membranes which lie back to back, with neither muscular nor connective-tissue cells intervening. This so-called "bridging" process, according to the older explanation, is due to an outgrowth of the mucosa and actual joining with tissues of the opposite side. Thinning out of the intertubular tissue due to dilatation of the tubules' individual branches, in our opinion, offers a more rational explanation of this phenomenon.

The second, or *cystic*, type of enlargement, is a further extension of this process. The cysts are usually small, but occasionally they are large enough to occupy half of the enlarged prostate. In a case observed by us, when the lateral lobe was opened most of the enlargement disappeared. Surrounding the groups of dilated tubules and their branches there was a layer of tissue of varying thickness and mostly fibrous. Occasionally, however, considerable smooth muscular tissue may be demonstrated when stained by van Gieson's method.

The third, or *fibroglandular*, type of hyperplasia appears when an unusual amount of fibrous tissue has been laid down. If this process is very intense, there will be a great increase in fibrous connective tissue or smooth muscle fibers, or both, which will produce a fourth, or *fibrous* type, with more or less compression of the tubular elements, which will not then display the glandular hyperplasia observable in the third type.

Evidences of chronic inflammation may be seen in specimens illustrating any of these various types. Marked infiltration of small round cells may be observed near the basement membranes of the tubules. This increase in the cellular elements varies greatly in individual cases, and in some instances causes extensive induration. When a patient with an enlarged prostate refuses operation, prostatic massage will occasionally bring considerable relief by reducing the cellular elements and thus lessening the induration.

The much discussed question as to whether adenomas or fibromyomas predominate in prostatic hyperplasia is of little practical importance as actually it is established that a pure formation of either type never occurs. The softer, so-called "adenomatous" type, which is observed in about 90 per cent. of patients, may be considered as the rule; while the hard, sclerosed nodules, or the more generalized fibrosis, should probably be regarded as due to secondary inflammatory or congestive changes produced by the presence of the growth or by other pathological processes involving the gland.

Signs and symptoms. Benign enlargement of the prostate is usually an insidious disease, which develops slowly and is marked by gradually increasing urinary difficulties. The patient may first notice frequency of urination, then slowness in starting the stream, and shortly thereafter nocturia and dysuria. Many men regard these difficulties as evidence of advancing age and pay little attention to them. The condition gradually gets worse, and is usually accompanied by urinary infection. The bladder muscles weaken and lose their tone as the obstruction increases, making voiding more difficult and resulting in a chronic retention of urine. This residual urine irritates the bladder and predisposes to infection. The amount of residual urine steadily increases as the mechanism of discharge becomes more and more impaired until, finally, the urine may trickle out through the obstructed outlet, producing overflow incontinence. In the rare case, complete obstruction of urination may occur without any premonitory symptoms. Occasionally macroscopic hematuria may be present.

In the early stages of prostatic obstruction, the urine may show very little abnormality — only an occasional pus cell and, possibly, a trace of albumin. The specific gravity will usually be low. After infection has developed, much pus and blood may be found, as well as albumin. If the disease is of long standing, casts are found, and the phenolsulphonphthalein test will show diminished renal function. The blood urea is increased, sometimes very greatly; but unless there is fever, the blood count is usually within normal limits.

The symptoms are not proportional to the degree of enlargement but, rather, to the degree of obstruction present. Very slight enlargements of the gland, which intrude into the vesical orifice, may produce serious urinary obstruction; whereas a greatly enlarged gland, with but slight intravesical intrusion, may cause few, if any, symptoms.

Certain general constitutional signs and symptoms are associated with prostatic enlargement of long standing: backache, weakness in the legs, dizziness, shortness of breath, insomnia, gastrointestinal disturbances, and hypertension. Cardiac lesions and nephritis are often associated with, or may be directly caused by, prostatic obstruction.

The profound reaction to the back pressure resulting from prostatic obstruction is familiar to everyone. The muscle bundles of the bladder wall hypertrophy in their attempt to empty the viscus, causing trabeculations and elevation of the trigone, with the formation of a deep depression behind the interureteric ridge, referred to as a *bas-fond.* Eventually a portion of the bladder wall may give way, resulting in a diverticulum. The ureters, working against this back pressure, dilate and the kidneys suffer in their ability to excrete the poisons of the body. It therefore often happens that at the first examination of a patient with prostatic enlargement there will be found extensive damage to the kidneys, with a corresponding impairment of their function.

The most serious complications of prostatic enlargement are secondary infections in the urinary tract due to obstruction. Pyelonephritis, plus the effects of the back pressure, rapidly damages the kidneys, which, in turn, overworks the heart and results in a myocardial insufficiency.

Prostatic calculi are sometimes found in conjunction with prostatic hyperplasia, and benign hyperplasia and carcinoma often coexist.

Diagnosis. The patient should be given a careful general and special examination, which should include rectal palpation, estimation of the amount of residual urine (care being taken to allow the pressure to be resumed if there is extensive obstruction), determination of the renal function, and a cystoscopic examination to determine the exact nature of the enlargement. Cystography and cysto-urethrography are also of the greatest value in obtaining desired information regarding the extent of obstruction to the vesical orifice.

The size of the prostate, as felt by rectum, is no indication of its obstructiveness. A markedly enlarged prostate may be palpated by rectum in the absence of any signs and symptoms of obstruction to urination. On the other hand, the fact that the prostate is normal to rectal palpation does not rule out vesical neck obstruction, which may be caused by a fibrous bar or contracture, an enlargement of the subcervical group of tubules, or an enlarged median lobe. Since the removal of an enlarged prostate is usually contraindicated when there is little or no residual urine, it is essential to determine the degree of vesical neck obstruction produced by the hyperplastic gland. This can only be done by means of cystoscopy, cysto-urethrography, or a suprapubic cystostomy. Cystoscopy is also invaluable for determining the type of operation best suited for the removal of the particular obstruction under consideration.

Instrumentation should, however, be undertaken very guardedly in any patient with long-standing obstruction due to prostatic enlargement as even slight manipulation may precipitate an exacerbation of infection or an attack of urinary retention. Careful physical examination, to determine the general vitality of the patient, and the estimation of renal function are important prerequisites to any contemplated instrumentation in these cases.

Examination of the urine, blood chemical examination, phenolsulphonphthalein estimation, and the urea-clearance test will indicate to the surgeon the necessary precautions to pursue in preparing the patient for operation.

Treatment. *Palliative.* Many patients with benign enlargement of the prostate have few or no obstructive symptoms and do not require surgery. In cases with little residual urine, palliative and expectant treatment should be tried. This consists of: periodic prostatic massage, gentle dilatations of the urethra by means of sounds or the Kollman dilator, urethrovesical irrigations, the application of heat to the prostate through the rectum, hot sitz baths, and plenty of fluids. Hormonal therapy affords symptomatic relief in some early cases, with slight or moderate urinary disturbances. Roentgen irradiation, by alleviating the associated congestion and edema, has been found to give temporary relief in selected cases (see Roentgen-Ray Therapy of Benign Prostatic Hyperplasia).

Operative. Early operation on the properly prepared patient is the treatment of choice in cases with residual urine which does not subside under palliative treatment, and is now done much more frequently than formerly. The outcome without surgery, in patients with residual urine and retention, is uniformly poor, since hormonal and other forms of treatment have proved of little avail in these cases. The type of operation selected should be governed by the conditions present in the individual case. Unless the kidneys are seriously impaired, there is rarely a fatality; and even when the kidneys and heart have been seriously affected, the mortality is relatively low, considering the advanced age and physical disabilities of most of these patients. Prostatectomy or resection, properly performed, results in the restoration of the ability to void normally, but the operation cannot be expected to cure irreparable cardiovascular, renal, and vesical lesions. However, by establishing good elimination, it materially benefits even these conditions.

The surgical treatment of prostatic hyperplasia, and the preoperative and postoperative care of the patient, are fully considered under Operative Treatment of the Prostate Gland.

Hormonal Therapy. During the last decade the possibilities of the clinical application of hormonal therapy in benign hyperplasia of the prostate have engaged the attention of a host of responsible scientists both in America and Europe. The results produced thus far indicate that while sex hormones may produce a definite and even striking clinical improvement in certain patients whose prostatism is not too far advanced, and in some cases may even result in actual diminution in the size of the gland, these effects are likely to be only temporary. As yet, there is no pathological evidence that hormonal therapy will stop, or even inhibit for any considerable length of time, the hyperplastic process.

Both androgenic and estrogenic substances have been used. Of the androgenic substances, synthetic testosterone propionate is the most potent and the most widely used in this country. Laqueur and Van Capellen, after several years' clinical experience with the Dutch product hombreol, reported excellent results from its use.

The published reports show a great difference of opinion as to the results obtained from the use of androgenic substances in the treatment of this lesion. Some claim definite clinical benefits, while others have noted no substantial or lasting improvements following their use. A few have not only observed no beneficial effects but claim that, at times, testosterone seems actually to stimulate the hyperplastic process. Most authors report little or no reduction in the size of the prostate on rectal palpation or by cystoscopic examination.

At the present time, estrogenic substances are being tried out in the hope that they may be the answer to the problem of the control of prostatic hyperplasia. Diethylstilbestrol, synthesized in 1937 by Dodds and his coworkers, and diethylstilbestrol diproprionate are considerably more potent than estrogen, and have been found to inhibit the growth of the gonads of both sexes, as well as the seminal vesicles and the prostate. The use of estrogenic therapy in benign prostatic hyperplasia is still in the experimental stage, but a number of reports are already on record indicating that not only may marked functional improvement be expected from its use, but, in many cases, actual decrease in the size of the prostate. Whether or not these results are merely temporary, or whether prostatic hyperplasia can be controlled by adequate maintenance doses of potent estrogenic substances remains to be seen.

Hormonal therapy, it should be emphasized, is not a panacea. Even its most ardent advocates do not claim that sex hormones are to be considered a substitute for surgical relief in major prostatic obstructions. It has proved most useful in early cases of prostatism with slight or moderate urinary frequency, nocturia, and low urinary residual in the bladder. The consensus of opinion seems to be that, in these cases, it relieves and ameliorates the distressing symptoms and tends to arrest, at least temporarily, the hyperplastic process.

MALIGNANT TUMORS OF THE PROSTATE GLAND

1. CARCINOMA

Introduction. Carcinoma of the prostate gland presents the urologist with one of his most disturbing and challenging problems, first, because it is now known to be one of the most common, if not the most common, form of cancer in men, and second, because 90 per cent. of all men who seek relief ask for this relief too late. The diagnosis is nearly always first made after the growth has become so extensive that there is little or no hope of even controlling it, much less curing it. Most patients die within two years after the discovery of the growth irrespective of the treatment they receive.

There are several reasons for this tragic state of affairs: (1) Carcinoma, contrary to the general opinion, may, and does, occur in men below the age commonly associated with prostatic hypertrophy (50 years and upwards). (2) It may develop in silence and produce no urinary symptoms. (3) When urinary symptoms do occur, which is often, they are frequently regarded as natural physiological changes that are to be expected in men beyond the half-century mark. (4) Many men delay seeking medical aid because they fear urinary incontinence or sexual impotence as a consequence of surgical removal of the obstructing prostate. (The introduction of transurethral prostatic resection has somewhat lessened this fear.)

The only hope of obtaining successful results lies in the early discovery of the growth, while it is still small and confined to the prostate, when hope of cure may be expected. Fortunately, about three-fourths of the growths originate in the portion of the prostate lying directly beneath the rectum, where even early and small areas of cancerous change in the gland can be discovered by rectal palpation. Since these early changes are usually asymptomatic, the hope of early diagnosis lies primarily in their accidental discovery (and subjection to biopsy) in the course of routine medical examination which includes rectal palpation of the prostate. The first step in the control of prostatic carcinoma is, therefore, the making of routine palpation of the prostate a part of every general physical examination of males over 45 years of age.

Etiology. The etiology of prostatic carcinoma is not clear. Chronic hypertrophy has been mentioned as the chief predisposing condition (Ewing). Moore found prostatic carcinoma to be intimately associated with senile atrophy, and believes that in most cases it results from stimulation and autonomous proliferation of epithelium which has already undergone atrophy. Hryntschak thinks that there is an etiological connection between carcinomatous and regenerative proliferations of the prostatic tissues. In 1936 he advanced the hypothesis, based on the histological study of 310 operative specimens, that carcinoma develops from multiple regeneration centers, the individual carcinomatous foci then growing toward each other and fusing, in the end presenting the well-known picture of prostatic carcinoma. The malignant proliferations each issue from a separate regeneration focus and present structural diversities dependent on the different kinds, or stages, of regeneration, thus explaining the striking morphologic peculiarity of prostatic carcinoma that has been emphasized by most writers, namely the diversity of its forms and the fact that in the same tumor, in different portions, may be found adenocarcinoma and medullary, scirrhous, or squamous-cell carcinoma. Huggins has recently suggested an entirely new concept, namely that there is a relationship of androgenic hormones to carcinoma of the prostate (see p. 746 (84)).

Incidence. Extensive pathological studies during the last three decades have conclusively shown that carcinoma of the prostate gland is a much more common form of malignancy than was formerly supposed. Young's statistics (1936) reveal that one-fifth of the male patients who seek relief of obstruction of the vesical neck have carcinoma of the prostate. Rich (1935), in 292 consecutive routine autopsies on men over 50 years of age, at the Johns Hopkins Hospital, found an incidence of 14 per cent.; in

68 per cent. the tumor had not been discovered because it was too small to produce symptoms. He concluded that the true incidence must be considerably higher inasmuch as he had examined only a single section of the gland in each case and therefore must have missed malignant areas in many instances. Robert A. Moore (1935) found prostatic carcinoma in 21 per cent. of 252 prostates from subjects between 41 and 90 years of age examined by him.

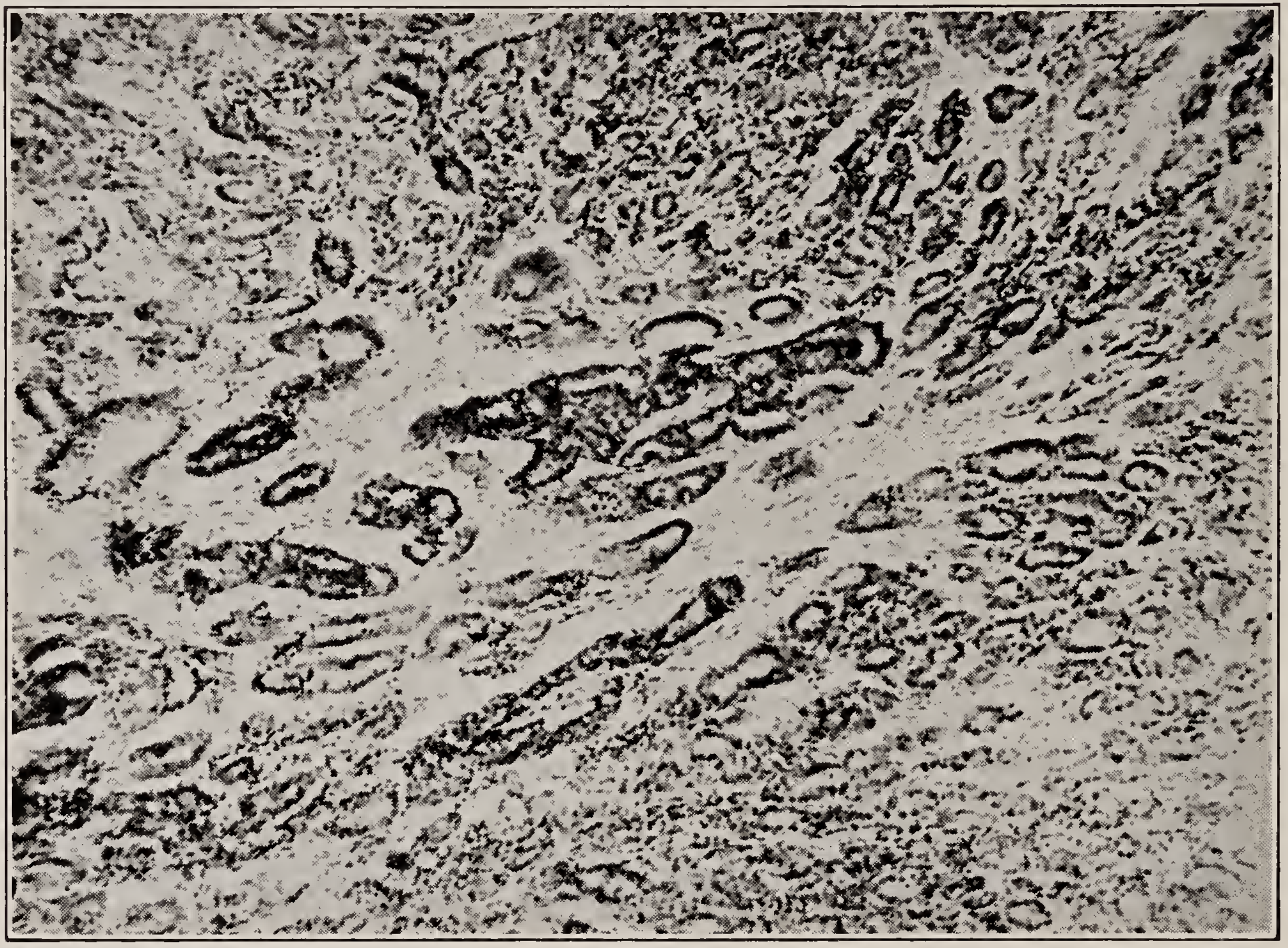

Fig. 30. Photomicrograph of carcinoma of the prostate gland, showing advancing edge of the new growth. The tubules affected are filled with cells.

Gaynor (1938), in a study of multiple sections of the prostate in 1,000 autopsies on men over 40 years of age, found an incidence of 18.4 per cent.

The incidence of prostatic carcinoma increases with age.

Pathology. In the early stages, carcinoma of the prostate may appear in a single focus or in multiple foci. About 75 per cent. of these cancers originate in the posterior lobe. This conclusion, originally voiced by Geraghty and Boyd in 1922 and repeatedly challenged, is borne out by the later and extensive studies of Moore (1934), Rich (1935), and Barringer (1936). The remaining 25 per cent. originate in the anterior, lateral, or median lobe. Gaynor found that in 98.5 per cent. of his cases the growth began at the periphery of the lobes. Rich also notes that the growths are situated near the outer borders of the gland and tend to invade the capsule, and states that the location of the early tumor suggests that the nonhypertrophied senile prostatic tissue and compressed atrophic glands are the favorite sites of origin.

From its usual origin in the posterior lobe, the carcinomatous process extends upward to the base of the prostate, where it penetrates the prostatic capsule and involves the seminal vesicles. Only rarely is the rectal wall invaded, being protected, in the region of the prostate, by the interposition of the fascia of Denonvilliers which is devoid of lymphatics and which, therefore, prevents the extension of the growth. Eventually the growth infiltrates the entire gland and the subtrigonal region, causing a varying degree of urinary obstruction. Infiltration of the perineural lymphatics, followed by metastases to the pelvic nodes and thence to the pelvic bones, usually occurs fairly early.

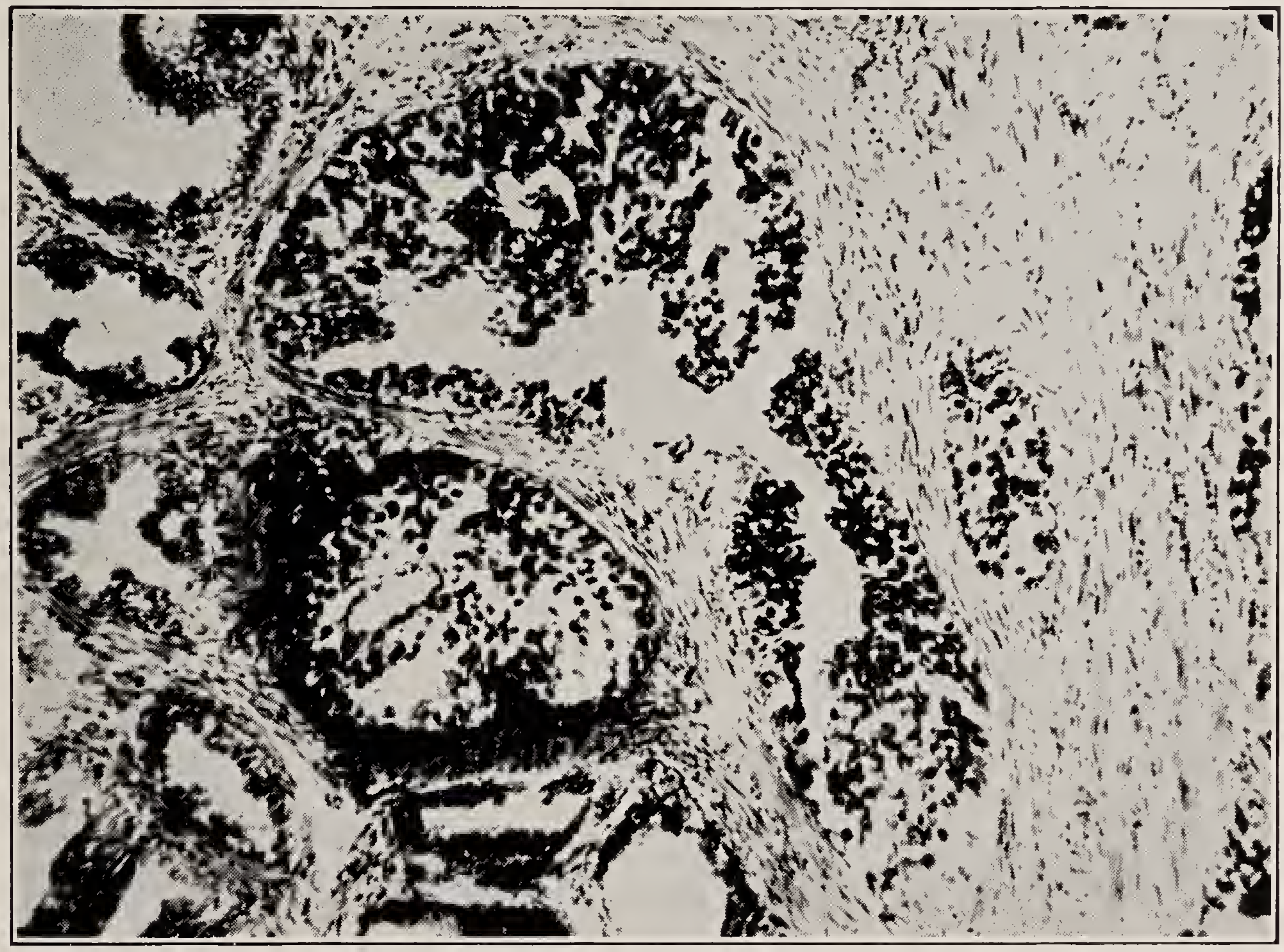

FIG. 31. Photomicrograph (high power) of carcinomatous tubules which are filled with epithelium composed of cells showing various grades of mitotic changes. At the left of the slide are to be seen several unaffected tubules which are lined with the characteristic columnar epithelium of the normal prostatic tubule.

Adenocarcinoma is the commonest type of prostatic cancer. Wilson and McGrath describe a great variety of arrangement in the adenocarcinomatous tissues. The acini of the tumor may be small, numerous and crowded together, with compressed cylindrical cells of the aberrant type; or they may be large and loosely filled with aberrant cells containing metachromatic nuclei. In most instances cancer cells infiltrating the stroma can be readily demonstrated. In medullary carcinoma the cells are relatively large, polygonal in shape, with swollen chromatophilic nuclei, and are supported by a delicate capillovascular network. The scirrhous type shows infiltrating lines or groups of aberrant cells with densely staining nuclei scattered through a superabundant stroma. The stroma itself is frequently infiltrated with small cells containing densely staining nuclei, and is apparently proliferating.

The different types of prostatic cancer differ fairly widely in malignancy. There is a fibrotic tumor, — usually found in men over 65 years of age and in prostates that have long been the sites of benign hypertrophy — that is relatively insidious and slow-growing, and is often only discovered upon removal of the prostate because of the benign enlargement. These tumors may remain confined to the prostate and periprostatic region for long periods, so that patients may survive for years without treatment. Metastasis occurs late or not at all. Then there is a smaller group of highly anaplastic tumors which are usually found in men of about 55 years and in prostates that have undergone little hypertrophic change. These run a rapid course and metastasize early and widely to bones and other organs. Between these two extremes are intermediary types of growths.

Metastasis. Carcinoma of the prostate does not usually remain a local disease for long periods. Most of the growths are fairly slow-growing but metastasize early and often extensively. The prostate is richly supplied with lymphatics, through which carcinoma extends to the pelvic nodes or, by the perirectal plexus, to the abdominal nodes. Dissemination through the blood stream may occur early, and distant metastases, particularly in the bones, are often detected before the occurrence of local symptoms. The small prostatic carcinoma often disseminates widely.

The high frequency of bone metastases in carcinoma of the prostate is attested by many observers, including Bumpus (26 per cent.), Duncan (27 per cent.), Marks (50 per cent.), and Kaufmann (70 per cent.). Skeletal metastasis usually involves the pelvic bones, lumbar spine, or the bones of the skull. Graves and Melitzer, in a clinical review of 81 cases of carcinoma of the prostate, found x-ray evidence of metastasis to the pelvis and sacrum in 85 per cent. and to the lumbar vertebræ in 59 per cent., while the femora was involved in only 35 per cent. and the dorsal spine in 23 per cent. Metastases other than to bone are most frequently found in the lungs, liver, pleura, and the pelvic and para-aortic lymph nodes.

Graves, Warren, and Harris, from studies on autopsy and operative material and clinical observation of patients, concluded that the chief factors in the marked preponderance of pelvic and lower vertebral involvement are the wide distribution of the periprostatic nerves and the conduction of tumor along the perineural lymphatics into close contact with bone (bony pelvis, sacrum, and lumbar spine). This perineural lymphatic dissemination of the tumor may be either by continuity or (rarely) through embolism. The pain which is a relatively early symptom of prostatic carcinoma is clinical evidence, these investigators believe, of the existence of this perineural lymphatic involvement, which they found to be a constant feature in practically all the cases of carcinoma of the prostate studied by them.

Associated pathology. A high percentage of cases of carcinoma of the prostate are associated with benign hypertrophy. Of Wilson and McGrath's 72 cases, 51 showed marked glandular hypertrophy, as was evidenced microscopically by papilliferous projections into the acini; 30 showed definite muscular atrophy; 61 increases in the fibrous stroma; while 10 showed no evidence of associated hypertrophy. Whether the hypertrophy in these cases was primary and the carcinoma implanted on it could not be determined, although in many microscopic sections the apparent transition by almost imperceptible variations from simple hyperplasia to undoubted carcinoma was observed.

In a study of 252 prostate glands from men between the ages of 41 and 90 years, Robert A. Moore found the occurrence of carcinoma and benign enlargement to be as follows:

Prostates examined	252	
Per cent. showing carcinoma	20%	(51)
Per cent. showing benign enlargement	57%	(144)
Per cent. of carcinomas which arose in a prostate with benign enlargement	51%	
Per cent. of benign enlargement which also showed carcinoma	20%	

It is evident, therefore, that the possibility of carcinoma must be kept in mind in every case of prostatic hypertrophy, particularly in the higher age brackets.

Symptoms. The first symptoms of prostatic carcinoma are usually some disturbance of urination — dysuria, frequency, nocturia, slow stream — and are not easily differentiated from those of benign hypertrophy, which often is present at the same time. Advanced prostatic cancer may, however, be present without urinary symptoms. Retention and terminal hematuria are later manifestations, and are frequently the reasons for the patient seeking medical advice. Pain is a prominent symptom in about 65 per cent. of the cases, and is the initial symptom in about 5 per cent. The pain may be referred to the sacroiliac region, perineum, rectum, inguinal regions, or thighs, and may be due to skeletal metastases. Due to the fact that clinical symptoms usually do not occur until the growth has progressed to a sufficient degree to cause urinary obstruction, metastases are often present when the patient is first seen.

Diagnosis. In extensive cases, the diagnosis is made without difficulty, on the history, digital examination of the prostate gland per rectum, and microscopic examination of a specimen of tissue removed from the growth. The demonstration, on rectal palpation, of a hard nodule or nodules in the prostate, or of an irregular, unyielding or stony hard area, should always make one suspect carcinoma. The indurated area may be localized or diffuse. Ill-defined margins and fixation or extension to the adjacent tissues, even in the absence of the usual stony hardness, are strongly suggestive of carcinoma. Evidence of a fixed gland may be seen on cysto-urethroscopic examination.

If rectal palpation reveals a suspicious nodule or indurated area in the prostate, a specimen or specimens of tissue from the suspected area should be removed by means of an instrument such as the author's biopsy punch, and submitted to serial section. Aspiration biopsy is successful in establishing the diagnosis in a majority of the cases, but, unless positive, should not be considered diagnostic. Negative findings cannot always be accepted as proof positive of the absence of malignancy.

In early cases, the diagnosis may be extremely difficult. A small, single nodule may easily escape notice, especially when superimposed upon a benign hypertrophy. The greatest obstacle to the detection of early cases, however, is the absence of symptoms in the early stages of prostatic cancer unless there is also present some degree of benign hypertrophy. The greatest hope of early recognition, therefore, lies in the routine medical check-up, which, in all men above the age of 45 years, should always include a careful rectal examination. In the past, over 95 per cent. of cases of prostatic carcinoma have been beyond hope of operative cure when discovered. Of 351 consecutive cases in Barringer's series only 16 (4.5 per cent.) were confined to the prostate and the periprostatic area.

Both cystoscopy and cysto-urethrography are valuable diagnostic aids in certain types of cases of prostatic cancer, namely the 25 per cent. or more of cases that originate in portions of the gland other than the posterior lobe, and those cases that originate in the posterior lobe and have progressed to an extent sufficient to produce vesical neck obstruction with urinary symptoms. Cystoscopy will give valuable information regarding the nature of the obstruction; and cysto-urethrograms will often show changes in the urethral shadow that are suggestive of cancer, such as lengthening, narrowing, and straightness, or rigidity and distortion of the urethra.

A careful search for metastases, particularly in the bones, is essential in all cases of prostatic carcinoma. Skeletal metastases occurring with carcinoma of the prostate must be differentiated from Paget's disease of bone, which is also a disease of later adult life. This is not usually difficult, but occasionally there may be confusion. The differential diagnosis is dependent upon x-ray examination. DeVries emphasizes the following important points in the differential diagnosis of metastatic carcinoma and Paget's disease: (1) Regarding distribution, although the spine, pelvis and long bones may be affected by either disease, a skull lesion will most likely be Paget's disease, a rib lesion most likely carcinoma. (2) Regarding local appearances, thickening, increase of coarse trabeculations, bowing and deformity, increased cortical density, and decrease of the marrow space are the important findings in Paget's disease, whereas absence of these signs, with spotty areas of increased density, decreased density, or both, are the significant findings in bone metastases from carcinoma of the prostate. This mottled, spotty appearance probably represents minute areas of tumor cells surrounded by new bone.

The study of phosphatase activity — " acid " and " alkaline " — is a new and interesting diagnostic factor in carcinoma of the prostate with metastases. In 1936, Gutman, Sproul, and Gutman observed that alkaline and acid phosphatases are markedly increased at the site of osteoplastic metastases of prostatic carcinoma. In 1938, Gutman and Gutman, and Barringer and Woodard found that acid phosphatase in the blood serum of many patients with metastatic lesions from prostatic carcinoma was increased above the level for normal men. *Marked* increases in acid phosphatase of serum have been observed only in prostatic carcinoma. At the present time, elevation of alkaline phosphatase of serum is regarded as indicating only bone or liver disease. Since the latter occurs infrequently in carcinoma of the prostate, while extensive skeletal metastasis is common, it is assumed that elevation of alkaline phosphatase of serum in prostatic carcinoma is usually due to bone lesions, in the absence of liver disease.

In 1941, Dr. Charles Huggins and his associates, of Chicago, presented evidence for their concept " that carcinoma of the prostate often is composed of epithelial cells of a mature type which, in common with all other types of adult prostatic epithelium, is responsive to depression of the level of androgenic hormones in the organism " (Huggins, Scott, and Hodges, 1941). This concept was based on studies of histological sections of the prostate for the presence of acid phosphatase. This enzyme is present in small amounts in human prostate glands in infancy and childhood and is increased during puberty to the high levels found in the adult. The fact that in each of 8 cases, in which the primary prostatic cancer was examined for acid phosphatase, the high content and distribution of this enzyme in the cells resembled those of normal prostatic epithelium, led these investigators to conclude that many (if not all) of these cancers consist of " a malignant type of adult epithelium rather than of neoplastic cells of a more primitive type."

In a group of 25 men with roentgenological evidence of metastatic carcinoma to the bony pelvis, Huggins and Hodges found that both the acid and alkaline phosphatases were increased above normal in 19 cases, only alkaline phosphatase was increased in 2 cases, and both values were within normal limits in 4 cases. They also found that the activity of disseminated carcinoma of the prostate was increased by the injection of androgen, as was evidenced by a marked rise of acid phosphatase; and was decreased by significantly lowering the androgen level by castration or estrogen injection, as was evidenced by a sharp decrease in the activity of this enzyme, which usually but not always reached a point near the upper limits of the normal range. Failure of the acid phosphatase of serum to reach a low level following castration presumably is due to the production outside the testis (particularly in the adrenal) of sufficient androgen to activate the carcinoma.

Elevation of serum phosphatases in prostatic carcinoma is interpreted by Huggins, Scott, and Hodges in the following terms:

When acid phosphatase is greatly increased (e.g., above 10 units per 100 cc.), carcinoma of the prostate with metastasis has always been present, but prostatic cancer with metastasis may be present without elevation of the serum phosphatases; thus, there are false negatives but no false positive reactions in this test. When the acid phosphatase is abnormally high, most of the increase is derived from the malignant prostatic tissue, which is usually not embryonic but of an adult type and so is androgen sensitive. It is tentatively assumed that maintenance of elevated acid phosphatase in certain cases following castration is due, at least in part, to the formation of androgens in extratesticular regions. In the absence of hepatic disease, the increased alkaline phosphatase values are largely derived from disturbances of the osseous system and are believed to be due to increased osteoblastic activity.

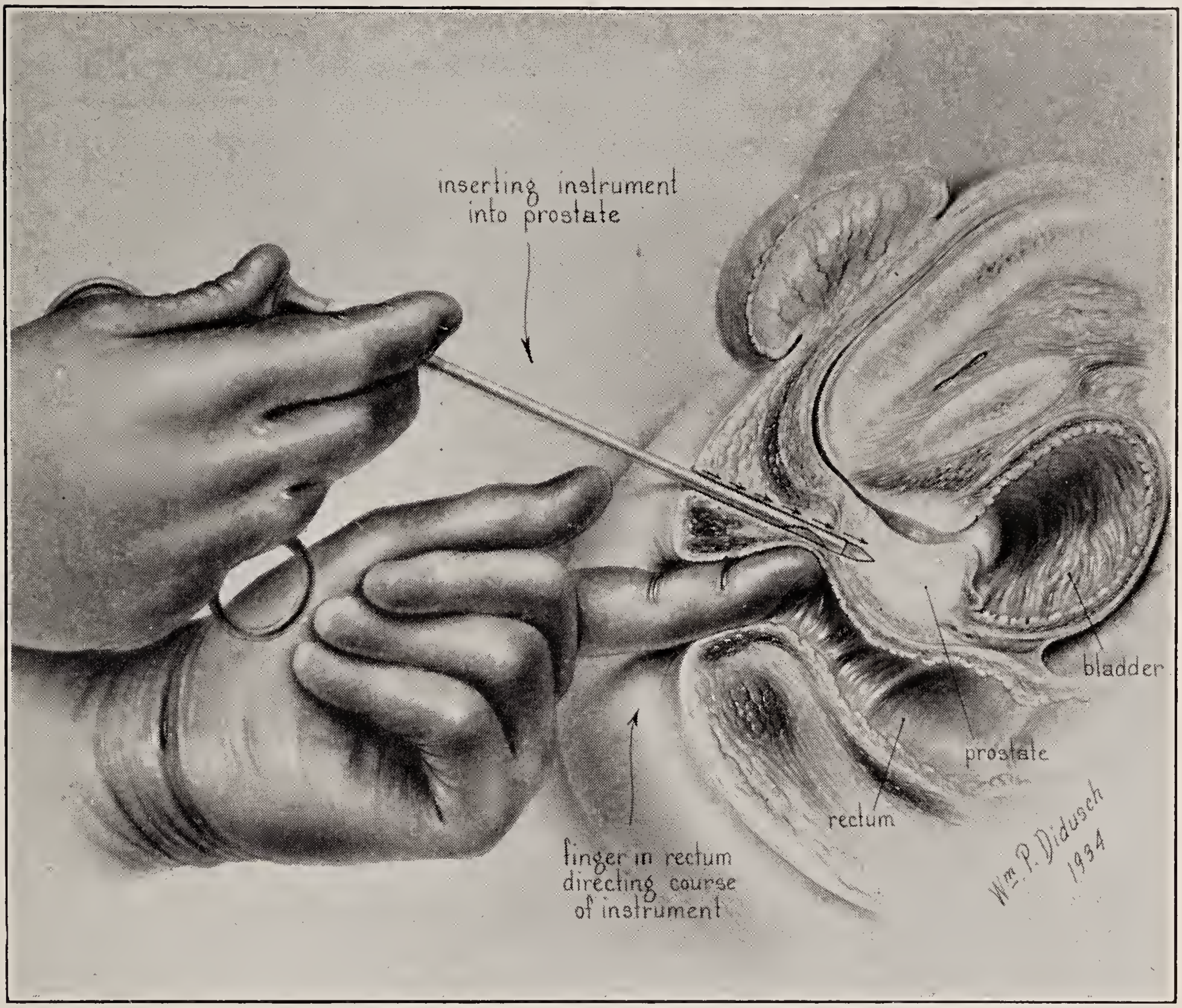

FIG. 32. Lowsley biopsy instrument. Sagittal view of the insertion of the instrument into the prostate. Pressure is made by the finger in the rectum in such a manner as to force the suspected tissue into the open fenestra.

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The study of phosphatase activity is helpful in the differential diagnosis of prostatic carcinoma with bone involvement and Paget's disease of bone, since it has been demonstrated that the phosphatase activity in serum from patients with metastatic lesions from prostatic carcinoma is greatest at low *p*H, or acid levels, while that from patients with Paget's disease of bone is greatest at high *p*H, or alkaline levels.

Lowsley biopsy punch. The author's biopsy instrument (Figs. 32 and 33) consists of an outer cylindrical tube 0.6 cm. in diameter, with a fenestra 1.5 cm. long at its distal end and a double-lever thumb-and-forefinger arrangement, resembling a scissors handle, at its proximal end. The inner cutting tube is fitted on its distal end with a sharp, triangular spear-like point designed for easy insertion. With the finger in the rectum as a guide, this instrument is introduced into the prostate through a stab wound in the perineum. While penetrating the tissues, the inner cutting tube is rotated so that its fenestra is turned away from the fenestra of the outer tube, closing the latter. When the instrument has reached the suspected area in the prostate, the inner cutting tube is again rotated so that the two fenestræ coincide. Pressure is made by the finger in the rectum in such a way as to force the suspected tissue into the open fenestra. By pressing the lever at the proximal end of the instrument the inner cutting tube, which is armed with small teeth, is withdrawn, and the suspected tissue penetrating the fenestra is thus excised as the cutting tube passes out of the fenestra of the outer tube. Proper manipulation of the instrument will cause the excision of rather large pieces of tissue (1 to 1.5 cm. long). After the specimen has been obtained, alcohol may be injected into the instrument as it is withdrawn (or an electrode may be introduced), for the purpose of destroying any cancer cells that may have been dislodged.

It may be necessary to take biopsy specimens from more than one section of the prostate for serial section.

Prognosis. There *is* hope of cure of prostatic carcinoma, but early discovery of the lesion is paramount if a permanent cure is to be had. The medical profession as a whole should therefore be stimulated to recognize this disease in its early stages, while complete surgical removal is still possible. This, as has been pointed out, is not always easy; but making rectal palpation a part of every routine physical examination of men over 45 years of age, and careful microscopic examination of a specimen of tissue from

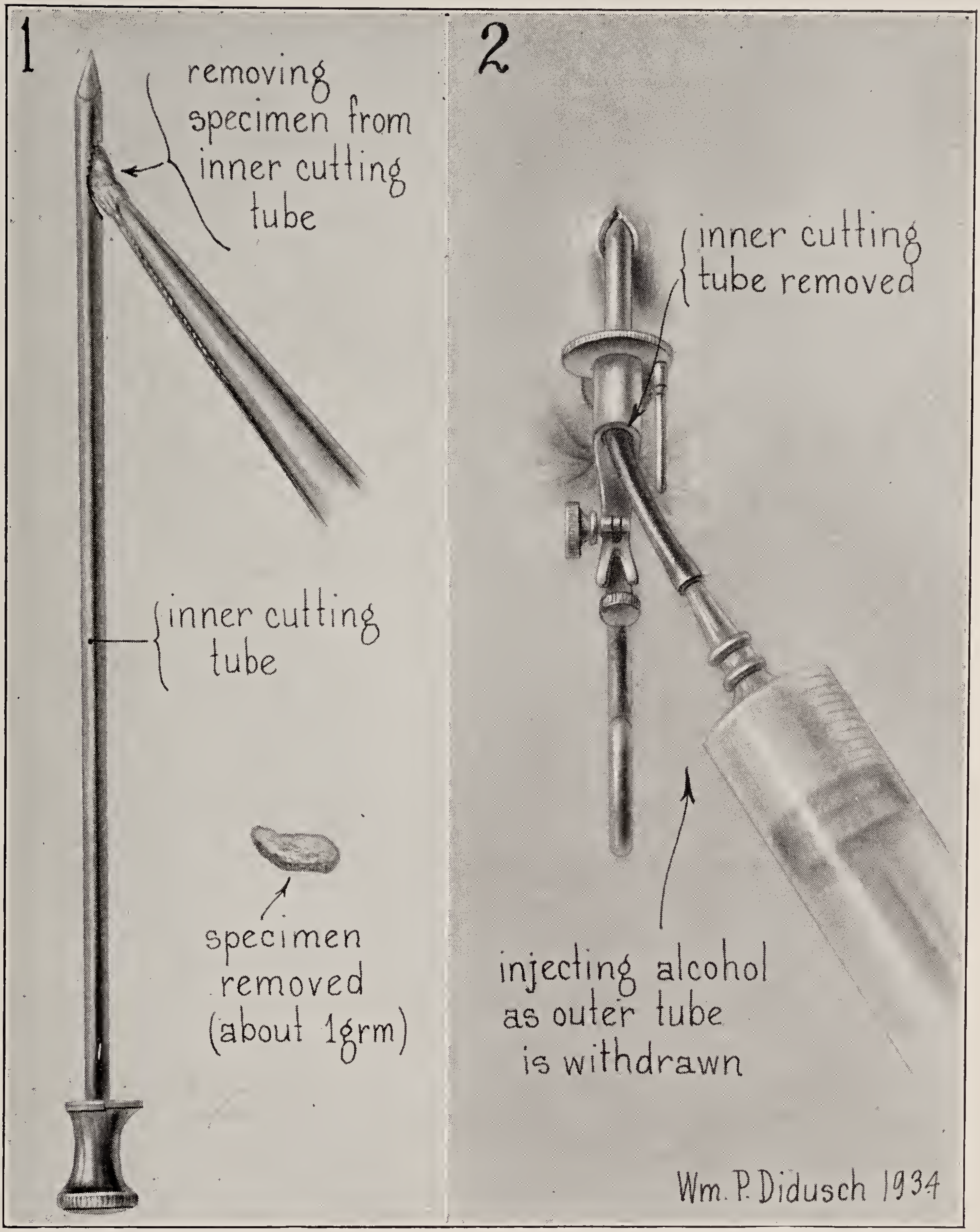
1
removing specimen from inner cutting tube
inner cutting tube
specimen removed (about 1grm)
2
inner cutting tube removed
injecting alcohol as outer tube is withdrawn
Wm. P. Didusch 1934

FIG. 33. Lowsley biopsy instrument. (1) Removing the specimen of tissue from the inner cutting tube. (2) After the inner cutting tube has been removed, a small catheter may be introduced through the outer sheath and alcohol injected through this as the outer tube is withdrawn, to prevent distribution and implantation of cancer cells.

every suspicious area within or adjacent to the prostate, undoubtedly would result in the diagnosis of many of these tumors while they are still confined to the prostate and periprostatic area, when radical surgery offers a good chance of cure.

When the extent of the local tumor or the definite presence of bony metastases precludes the hope of radical cure, treatment can only be palliative; but the therapeutic measures available will provide relief of suffering in many cases and postponement of death — sometimes for years.

Treatment. No tumor of the genito-urinary organs presents a more perplexing therapeutic problem than adenocarcinoma of the prostate. Without a doubt, the best treatment is complete surgical removal by means of radical perineal prostatectomy; but with few exceptions, these tumors develop asymptomatically for so long that, when they are discovered, less than 5 per cent. are operable. Irradiation, by radium and x-ray, while extensively employed, can at present be considered palliative only. Urinary obstruction can be relieved by transurethral resection of the obstructive prostatic tissue or by conservative prostatectomy, but neither of these procedures is curative. Castration — the newest method of treatment and originally employed by Huggins and his coworkers — effects a significant improvement in the clinical condition of many patients with advanced cancer of the prostate, but insufficient time has elapsed to tell whether complete regression of the tumor ever follows.

Radical prostatectomy — that is, removal of the prostate gland and its capsule, the seminal vesicles, and the prostatic urethra — appears to be the only curative procedure; and this is applicable only when the growth, as ascertained by careful rectal examination, is confined to the prostate, its capsule, and the bases of the seminal vesicles, and has not extended into the membranous urethra. The age and general condition of the patient are also important factors. Since an early diagnosis is necessary to discover these growths while they are in this stage, very few urologists in the past have encountered many cases suitable for the radical operation; but as clinicians become more alert in searching for cancer of the prostate, it is to be expected that many more cases will be recognized at a stage when hope for a radical cure can still be entertained.

There is a difference of competent opinion as to whether the radical procedure should be done when there are demonstrable bone metastases. Some clinicians believe that it should not be done; others, that if the tumor is small, the patient's general condition good, and metastases not too widespread, removal of the local growth may retard the metastatic disease, lessen the patient's discomfort, and prolong his life.

It is the author's opinion that men with early carcinoma of the prostate should have the benefit of total prostatectomy whenever possible. The reluctance of many surgeons to undertake the radical operation has been due largely to the overstressing of its difficulty and risk to the patient. In addition, there is a widespread impression that total incontinence of urine is the almost inevitable result of operation. When performed on carefully selected patients, and by a surgeon with thorough training in perineal work, the operative mortality should be no greater, and the postoperative complications no more prevalent, than in prostatectomy for benign hypertrophy. Moreover, damage to the external sphincter — the cause of postoperative urinary incontinence — can be largely avoided by the recent improvements in technical details, especially in methods of placing sutures to complete the anastomosis between the membranous urethra and the neck of the bladder (see Total Prostatectomy, p. 746 (111–56A)).

In the frequently seen advanced cases, where total prostatectomy is obviously impossible either because the local growth or the metastatic involvement is too extensive, or because the patient's age or general condition precludes it, the object of palliative treatment — whether by surgery, radium, x-ray, or a combination of these methods — should be threefold: (1) the preservation, as far as possible, of normal urinary function, (2) the relief of pain, and (3) the prolongation of life.

When the disease is too extensive for radical removal, but there are few or no obstructive symptoms, the patient is frequently treated by a combination of surface applications of radium, or interstitial irradiation by means of radium needles or seeds, and deep x-ray therapy directed not only to the prostate itself but also to probable metastatic areas. By the combined use of radium and deep x-ray the local growth can often be controlled for a considerable period of time and even made to retrogress, and by deep x-ray the pain of metastasis can usually be alleviated, at least temporarily.

In the type of inoperable case most frequently seen by the urologist, however, the symptoms are caused by urinary obstruction. In such cases the question arises as to which type of operation gives the more satisfactory results so far as relief is concerned — transurethral resection or conservative perineal prostatectomy. Transurethral resection is widely employed for removal of the obstructive carcinomatous tissue, and unquestionably has proved a distinct boon to many patients. Formerly we felt that transurethral resection was the preferred method of handling inoperable cases with obstruction. In a considerable percentage of cases, however, the electrical current so seriously affects the devitalized malignant tissue that necrosis and persistent infection result. There is also considerable evidence that resection of part of a carcinomatous prostate speeds up growth of the remaining malignant tissue, often necessitating a secondary operation within a short period. At the present time, we are inclined to favor conservative perineal prostatectomy in the case of larger neoplasms, especially those associated with a considerable degree of benign hypertrophy, when large amounts of tissue must be removed to relieve the obstruction. Radon seeds can then be implanted through the perineal incision under direct vision, if desired. Several of our patients have lived as long as 6 years, and the majority live from 2 to 3 years without recurrence of symptoms.

The use of radium or x-ray, or, preferably, both following resection or conservative prostatectomy has a tendency to postpone the recurrence of the growth (see Radium and Roentgen-ray Therapy of Prostatic Carcinoma, p. 746 (111–72A)).

Suprapubic cystostomy, formerly used almost as a routine measure for the relief of patients with growths too extensive for radical removal and with obstructive symptoms, has been superseded to a considerable degree by transurethral resection. Because of the desirability of preserving normal urinary function as far as possible, most urologists reserve suprapubic cystostomy for those cases in which resection or conservative prostatectomy for the relief of obstruction is contraindicated by the late stage of the disease and the poor condition of the patient.

Castration has already been mentioned as the newest method of affording palliation in advanced or metastatic carcinoma of the prostate gland. This procedure was originally suggested by Dr. Charles Huggins and his associates, who in 1941 presented evidence that most prostatic cancers are composed of epithelial cells of a mature type and, in common with all other types of adult prostatic epithelium, are influenced by androgenic activity in the body. Eliminating the gonadal androgens by castration, or neutralizing their activity by estrogen injection, they found, decreased the activity of this neoplasm, whereas injection of androgen increased it. These workers do not claim that castration cures protastic cancer, but they do claim that it effects a greater improvement in the clinical condition of many patients with far advanced or metastatic carcinoma than has been achieved by any other method of treatment. The objective evidences of benefit following orchidectomy are enumerated by Huggins as follows: (1) great decrease (usually) in the levels of serum phosphatases (see p. 746 (84)); (2) increase in weight and appetite; (3) improvement in red cell and hemoglobin values; (4) decrease in the amount of pain; (5) shrinkage of the primary lesion on rectal palpation and cystoscopic examination; (6) stabilization or regression of bony metastases in roentgenograms; (7) decrease in the size of palpable lymph nodes which were the seat of metastatic cancer (in two cases).

Inactivation of the male sex hormone by estrogen is still in the experimental stage, but encouraging results have already been achieved along this line.

In 1941, Dr. Arbor D. Munger reported his experiences in the treatment of advanced carcinoma of the prostate gland with supervoltage irradiation of the testicles. In 11 cases of prostatic carcinoma seen between 1933 and 1938, in which the patient had transurethral resection of the prostate with planned x-ray therapy, " each testicle was given directly an equivalent of 500 r. supervoltage therapy, over and above the necessary back-scatter which accompanies irradiation treatment applied to adjacent areas in these cases." Eight of these patients were living at the time of the report, the longest time of survival being 7 years, the shortest 3 years — somewhat better results, this author states, than were obtained in parallel cases treated by resection and x-ray exclusive of the testicular application.

At the Brady Foundation, in the New York Hospital, castration has been done in numerous cases of advanced and metastatic prostatic carcinoma during the past year, and it is our opinion that the claims of Huggins and his coworkers, regarding the beneficial results of this procedure upon the clinical condition of the patient in many cases, are in no way exaggerated. Usually two weeks or more are allowed to transpire following prostatic resection or prostatectomy for obstruction before orchidectomy is performed (see Orchidectomy for Carcinoma of the Prostate, p. 746 (111–49A)).

2. SARCOMA

Incidence. Sarcoma of the prostate gland is admittedly a rare disease. A review of the literature up to 1932 disclosed only 131 reported cases in which the diagnosis was undisputed (Lowsley and Kimball, 1934). To these we added a personal case. Stirling and Ash, in 1939, added 45 cases, bringing the total to 177. These authors state that in the five-year period preceding the publication of their review approximately 31,882 deaths occurred from prostatic cancer in the United States, among which were only 35 sarcomas (an incidence of 0.091 per cent.).

The age incidence is important. Although sarcoma of the prostate, like sarcoma elsewhere in the body, is found most frequently during childhood and youth, it is common to all ages. The youngest patient in the reported cases was 4 months old and the oldest 88 years. Our own patient was 64 years old, and 20 others in the series of 132 cases reviewed by us were over the age of 60 years. Occurrence is most common during the first decade of life, declining between the ages of 10 and 20 years, then increasing slightly until the age of 50 years, after which there is a gradual decline. The complete age incidence in the 132 cases just mentioned was as follows: under 10 years, 34; 11 to 20 years, 13; 21 to 50 years, 51; 50 to 60 years, 11; over 60 years, 21.

Etiology. The etiology of sarcoma of the prostate remains unknown. The most generally held theory is that it is the result of some embryonal cellular maldevelopment or inclusion. The relative frequency with which these tumors are found in childhood, and the large size of some when discovered in the first few months of life lend support to this viewpoint.

Pathology. On the basis of cell morphology at least 20 different types of prostatic sarcoma have been reported, including round-cell, spindle-cell, rhabdomyosarcoma, lymphosarcoma, fibrosarcoma, myxosarcoma, leiomyosarcoma, chondrosarcoma, myosarcoma, angiosarcoma, adenosarcoma, alveolar, medullary, and giant-cell. This confusion of terminology is strong indication that the pathological classification of sarcoma, and its differentiation from carcinoma, may be confused even by the pathologist. The histological classification in the reported cases was round-cell sarcoma in about 30 per cent. of the cases; spindle-cell in 20 per cent.; myxosarcoma in 8 per cent.; rhabdomyosarcoma in 6 per cent.; fibrosarcoma in 5 per cent.; and angiosarcoma in 3 per cent. The remainder were sarcoma, giant-cell, myosarcoma, etc.

Stevens and Barringer have proposed a simpler pathological classification of prostatic sarcomas based on their tissue origin. They suggest three groups: (1) myosarcoma (leiomyosarcoma and rhabdomyosarcoma), taking origin from the musculature of the prostate; (2) lymphosarcoma, arising from lymph tissue in the prostate (formerly a disputed entity, but now generally recognized); (3) sarcoma of undetermined origin — spindle-cell, round-cell, and giant-cell sarcomas, fibrosarcoma, and myxosarcoma. For clinical reasons they add a fourth group, not sarcoma at all, but anaplastic carcinoma, which has features resembling sarcoma and is often mistaken microscopically for lymphosarcoma.

Stirling and Ash do not believe that round-cell and spindle-cell sarcomas are the most common varieties, despite the relatively large number of such tumors reported in the literature. They state:

> We are convinced that if a critical study of the material from the reported cases could be made, that some, at least, of those diagnosed as spindle and round-cell sarcomas would prove to be of muscle origin. We believe, also, that where differentiation has gone to the extent of the appearance of cross-striations, the tumor should be called "rhabdomyosarcoma"; that a smooth muscle or leiomyosarcoma is not apt to be so pleomorphic as the striped muscle tumor, so, even in the absence of cross-striations, it is felt that those tumors with large, bizarre and multinucleated cells with ribbon-like cytoplasm are very apt to be rhabdomyosarcoma even in the absence of cross-striations. If any cross-striations are found, it means that all cells in the tumor are of striped muscle origin no matter how spindly or dedifferentiated they may be. The spindle cell may form the entire picture in a large portion of the tumor with only an occasional cell showing the striations. If it is felt that the term "rhabdomyosarcoma" should be limited to those tumors actually showing cross-striations, then the term "myosarcoma" or "myoblastosarcoma" may be used for those tumors that show no striations, but are pleomorphic, have ribbony cytoplasm and large multinucleated cells. This reserves the term "leiomyosarcoma" for those tumors that are predominantly spindle cell with a more limited pleomorphism and that can be differentiated from a fibrous origin by special stain.

In common with numerous other present-day observers, these authors feel that most of the cases that have been reported as round-cell sarcomas are, in reality, undifferentiated small-cell carcinomas.

Recently, Dr. Robert W. Hunt thoroughly reviewed the literature on rhabdomyosarcoma of the prostate and found reports of only 18 cases. To these he added a case in a 2½-year-old boy seen, in 1937, at the Brady Foundation, in the New York Hospital. He states:

> The normal striated muscle from which these tumors arise has been demonstrated in the anterior part of the prostate. Striated muscle fibers may be found in the region of the internal sphincter and adjacent area of the trigone. One can never prove the origin of these tumors, but it seems reasonable to believe that they arise from the normally present striated muscle elements in the region.

Prostatic sarcomas usually grow with great rapidity and attain large size. Numerous cases are cited in which the entire pelvis was filled with the rapidly growing tumor. Sarcomas in the earlier age groups are more malignant, metastasizing more freely and running a more fulminant course. They are larger and softer than in the aged. In older patients the tumors are firmer and often simulate a benign hypertrophy on digital examination.

Regional extension and metastasis. Prostatic sarcomas early infiltrate the bladder, retrovesical space, seminal vesicles, and rectum. Regional extension occurs in about 75 per cent. of the cases. It is common to all ages, but seems to be most marked during the first decade. Round-cell and spindle-cell sarcomas are the most malignant and show the greatest propensity for metastasis and invasion.

Metastases are found in about one-half of the cases, occur fairly early, and are most common in younger patients. Malignant cells are carried by both the lymphatics and the blood stream. The chief sites of metastases are the lungs, kidney, retroperitoneal and inguinal nodes, liver, and bones (particularly the ribs and vertebræ).

Symptoms. The symptoms are largely those of urethral and rectal occlusion. Growth of the tumor backward and upward and forward causes obstruction of the ureteral orifices, vesical orifice, and urethra, with resultant partial or complete retention accompanied by an ascending urinary infection. Growth of the tumor toward the perineum causes projection of the perineum and prolapse of the rectum, with obstruction of defecation and urination.

The early symptoms usually are dysuria and frequency. Later, there are pain and symptoms of obstruction of defecation or urination or both. The onset of obstruction is usually more rapid in the younger patients. The interference with urination may be due to pressure of the tumor mass on the bladder floor, or it may occur directly from the growth of the mass into the urethra, resulting in reduction of its caliber. The pain results either from partial or complete retention of urine, or from extension of the growth into the retrovesical space. It may extend over the abdomen, or there may be severe pain in the sacrum, perineum, or along the course of the sciatic nerves. Pressure of the tumor on the ureters is often sufficient to produce unilateral or bilateral hydronephrosis, with concomitant symptoms. Hematuria may be present but is not a prominent symptom. Marked loss of weight and secondary anemia are noted as the disease progresses.

Diagnosis. The presence of urinary or rectal obstruction in conjunction with palpable evidence by rectum of a large, oval mass of atypical (but usually elastic or semihard) consistency in the region of the prostate suggests prostatic sarcoma. In young patients, in particular, the tumor is likely to be smooth, tense, and of uniform consistency, with a soft or balloonlike feel; hence it has frequently been confused with prostatic abscess. These tumors are usually very malignant. In older patients, the less malignant sarcomas may be firm, smooth, and circumscribed, suggesting benign hyperplasia. Occasionally the tumor will be indurated and nodular. Cystoscopic examination may show displacement of the bladder forward, with elevation of the trigone and marked reduction of the bladder capacity due to the intravesical growth. It may also show nodular changes affecting the urethral contour.

The diagnosis of sarcoma of the prostate in children is less difficult since enlargement of the gland is unusual at this period of life. In older patients, the tumor must be differentiated from abscess, benign hyperplasia, carcinoma, tuberculosis, syphilis, and cyst of the prostate. Clinical differentiation is of great importance because of the uniformly poor results of surgery in sarcoma of the prostate. Absence of definite fluctuation and extreme tenderness helps to distinguish sarcoma from abscess. Differentiation from benign hyperplasia and carcinoma may be very difficult. Important indications that the growth is a sarcoma are the following: earlier age (usually) than in benign hyperplasia or carcinoma; rapid development of the growth; great size of the prostate; greater regularity and elasticity or semihardness of the tumor as contrasted with the irregularity or nodularity, hardness, and fixity of carcinoma. Roentgenograms may show characteristic osteoclastic metastases, as distinguished from osteoplastic metastases usually seen in prostatic carcinoma. Needle biopsy is of the greatest value in making the differential diagnosis.

The difficulty of differentiating a primary sarcoma of the prostate from sarcoma of the retrovesical space has frequently been pointed out. Usually, by the time the patient is first seen, the tumor mass involves both the prostate and the retrovesical space, as well as the bladder wall. Young has suggested that it might be better to refer to this group as " sarcomata of the prostate and adnexa " rather than attempt, except where the tumor is small and definitely confined to the prostate, to say where they begin.

Prognosis. The prognosis is bad, regardless of the type of treatment instituted, only a rare case being controlled for more than a few years by the present methods. This is due to early and extensive infiltration of the periprostatic tissues and early metastasis via both the blood stream and the lymphatics. The diagnosis is usually made late in the disease, after extension or metastasis, or both, have occurred, and the course is rapidly downward, with occasional temporary regression of the tumors subjected to irradiation. In childhood, the disease runs a particularly rapid course, terminating fatally very early after its onset, the average duration of life being about 5 months. In adults and those of advanced age, duration is longer, averaging about a year. Katzmann reports a case in an infant 13 months old which terminated fatally in 9 days, while Bumpus reports a case in a patient 59 years of age which was under therapeutic control for 7 years and 2 months.

The only apparent hope for better results is in early diagnosis and prompt treatment by irradiation, or by surgery while the tumor is localized to the prostate or, in certain cases, to the prostate and bladder. If all young males, as well as older men, with urinary disturbances were subjected to rectal palpation and needle biopsy of palpable prostatic nodes, many of these cases might be diagnosed sufficiently early for a cure to be obtained. In early cases rectal examination may be negative, but in the majority examination will reveal a palpable nodule which should arouse suspicion.

Treatment. There is at present no satisfactory treatment of sarcoma of the prostate. Due to the rapid onset of the disease, and the fact that in most cases the malignant process has extended beyond the confines of the prostate when first diagnosed, surgery has consistently proved unsuccessful. It has been the almost universal experience that operation only hastens the fatal outcome, even when followed by some form of radiation therapy. Most writers are of the opinion that surgery should be limited to the relief of obstruction to the bowel or bladder. However, if these growths could be diagnosed earlier, radical prostatectomy might effect a cure in some cases.

The best results to date have been achieved through the use of deep roentgen-ray therapy in combination with radium applied per rectum, intraurethrally, and intravesically (see Radiation Therapy of Malignant Tumors of the Prostate: Sarcoma). However, these also have been definitely discouraging. There have been numerous reports of patients who have been considerably benefited, but almost invariably the help has been but temporary. At present, the treatment of most prostatic sarcomas is directed toward relief of urinary obstruction by means of a permanent suprapubic tube, plus radium and deep x-ray treatment of the tumor.

Roentgen therapy, however, appears to be definitely contraindicated in rhabdomyosarcoma of the prostate since these radioresistant growths are not only not benefited but at times appear even to have been stimulated by irradiation. Hunt believes that, at present, early radical surgery (prostatectomy and total cystectomy, with transplantation of the ureters to the bowel) offers the best, if not the only, chance for a successful outcome as these tumors remain localized to the prostate and bladder for relatively long periods and seldom metastasize to distant organs. However, operation must be done before the growth has progressed to a stage where it has resulted in dilatation and infection of the upper urinary tract. He points out that prostatic rhabdomyosarcomas are being diagnosed more frequently and at an early stage, yet radical surgery thus far has wholly failed; and states that this failure is apparently due to the fact that too great a period of time is allowed to elapse between the time of diagnosis and the time of radical surgical intervention.

Author's case. The following case of prostatic sarcoma in a man 64 years old is described in detail because it illustrates the diagnostic difficulties present when the disease occurs in older men, when other enlargements of the prostate — notably benign hyperplasia — are common. Death in this case was apparently due to uremia following bilateral ureteral obstruction by an enormously enlarged and histologically sarcomatous prostate.

S. E. B., aged 64 years, entered the Department of Urology (James Buchanan Brady Foundation) of the New York Hospital on May 19, 1930, complaining of urinary frequency, dribbling, and painful micturition. The frequency was of 3 years' duration and had increased in severity until the patient voided hourly, day

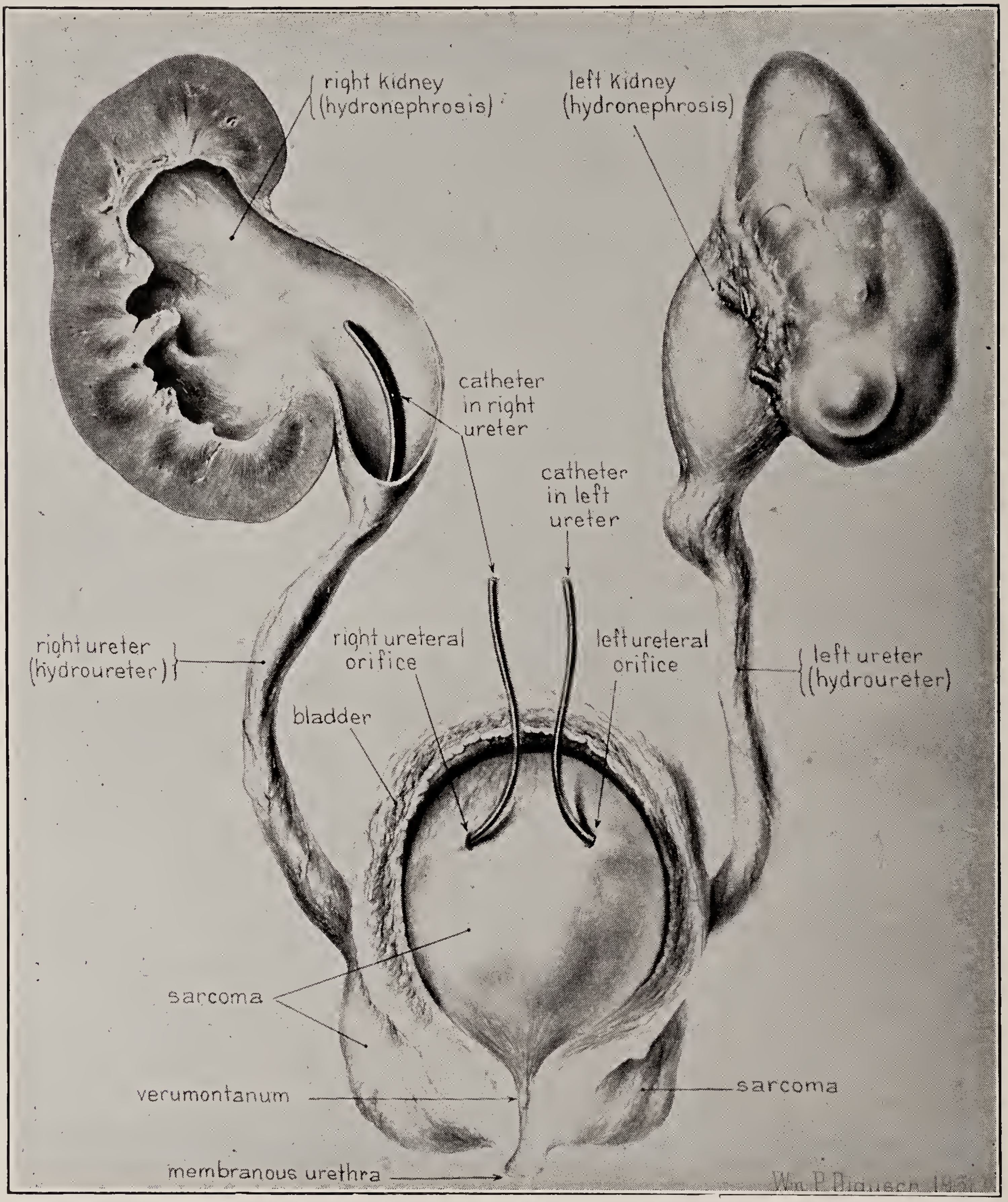

FIG. 34. Sarcoma of the prostate gland in a 64-year-old man. The drawing shows the bladder opened in the anterior midline, exposing the tremendous sarcomatous growth which almost completely fills the bladder. The catheters in the ureters show the extent to which the trigone has been elevated. Both ureters, although markedly enlarged, are patent. The right kidney has been bisected to show the extent of the hydronephrosis. The left kidney is also hydronephrotic and shows cyst formations on its surface. The musculature of the bladder wall is greatly hypertrophied and all evidence of the trigone is obliterated.

and night. The dribbling had been present for one year. At first it occurred only at the end of micturition, but at the time of admission was constant. Cystoscopy had been performed one month before admission and the patient told that he had a moderate intrusion of the prostate. Immediately following this procedure there was marked bleeding from the urethra, which gradually subsided.

His family and past personal histories were unimportant, except that he had had a gonorrheal infection at the age of 24 years, with an uncomplicated recovery, and a syphilitic infection at the age of 29 years, for which he received vigorous antisyphilitic treatment. The blood Wassermann reaction had been negative during the last 30 years.

Physical examination showed the heart to be slightly enlarged, and the blood pressure 170 systolic, 88 diastolic. Per rectum, the prostate was found to be about 2½ times the normal size, flattened, and leathery in consistency. It was our impression that the patient had a benign hypertrophy of the prostate. Further physical examination prior to operation failed to reveal anything unusual.

A suprapubic cystostomy was performed under regional block, and there was found to be moderate intravesical intrusion of the prostate. The patient made an uneventful recovery from the operation, but the kidney function failed to show any appreciable improvement. He was discharged from the hospital on June 20, removal of the prostate being deferred until a more favorable time.

On October 13, the patient was readmitted to the hospital. His condition had improved rapidly following the cystostomy, except that his appetite was very poor and his sleep greatly disturbed because of pain in the right side and flank, and an elevation of temperature. His temperature had, however, been normal for the past week. In the interim between admissions he had returned at frequent intervals for phenolsulphonphthalein and blood chemistry tests, but the kidney function was so poor that it was impossible to do the second stage of the operation. Upon his readmission to the hospital, another cystoscopy was attempted after the suprapubic tube had been removed from the wound and the latter tightly closed by digital pressure. The instrument passed without difficulty, although it seemed to assume a peculiar angle as it entered the bladder. There was found a tremendous intravesical intrusion of the median portion of the prostate. The urethral orifices could not be seen. The prostate appeared to be about the size of a hen's egg. On October 17, intravenous urography was done. Urograms taken three hours after injection showed the right kidney pelvis to be about five times the normal size and its ureter tremendously enlarged and distorted. The left kidney and ureter were not visualized in any of the urograms. In the right upper quadrant were outlines of six distinct shadows, which were thought to be gallstones.

The patient gradually grew worse; marked emphysema, bronchitis, and embarrassment to the circulation, with enlargement of the liver, developed. Death occurred on December 4, the probable cause of death being uremia.

An autopsy was obtained. The pertinent urological observations were as follows:

Kidneys. — Gross: The perirenal fatty tissue was considerable in amount and could be readily peeled from the kidneys, their capsules being removed with the surrounding fat. The right kidney felt soft and small; the pelvis was dilated to almost the size of the kidney proper and contained cloudy mucinous material. When the pelvis was empty, this kidney weighed 175 grams. The medullary portions seemed to be relatively more thinned out by the greatly dilated renal pelvis than the cortex. The kidney substance was 2.5 cm. thick around the pelvis. The left kidney seemed to be even more injured by the hydronephrosis than the right. After the pelvic fluid had been drained off, the kidney weighed 135 grams. The cortex was 1 cm. thick.

Microscopic: The left kidney showed extensive interstitial fibrosis and a moderate amount of lymphocytic infiltration, especially in localized areas. The tubules were quite sclerotic. The right showed a similar picture, with rather less fibrosis but much more marked cellular infiltration. Fairly numerous polymorphonuclear cells were found in addition to the very large numbers of round cells.

Ureters. — Both ureters were greatly dilated throughout, the dilatation extending to the bladder wall. They were fairly uniformly 1.5 cm. in diameter throughout, and contained thick white mucinous urine. Where the right ureter crossed the pelvic brim, its diameter was slightly smaller.

Bladder. — Gross: The bladder communicated with the suprapubic sinus, which appeared well preserved and showed no irritation. The bladder contained almost no urine. It was closed down so as practically to surround the prostate, without any remaining lumen. The prostate was enormous, being 8 cm. long, 5.5 cm. wide, and 4.7 cm. thick (i.e., about the size of a tennis ball). The ureters could not be recognized from within the bladder, but when probed into from the outside they were found to empty into the bladder on the most prominent portion of the anterior surface of the prostate. Their openings were very oblique, and a probe within them could be seen through the bladder mucosa almost 1 cm. above the point of opening. There were a few small diverticula superior to the prostate. On section, the prostate seemed to consist almost entirely of fibromuscular tissue. The enlargement seemed to be most prominent in the median lobe, but the lateral lobes were almost as much enlarged. Posteriorly, the seminal vesicles and ampullæ of the vasa deferentia were displaced somewhat laterally by nodular projections from the prostate. The ureters were displaced upward. The bulk of the growth grew into the bladder, suggesting that the process originated in the median lobe.

Microscopic: Several sections were studied. In all of them the picture was that of sarcoma, apparently of smooth muscle origin, as shown by van Gieson's stain (leiomyosarcoma). No glandular element was recognized in any section. The spindle-shaped cells varied greatly in size, and very large nuclei were found in many of the cells. There was very little cellular infiltration. (Pathologist's comment: "Although we are listing this case as sarcoma, we do so largely on histologic grounds.")

Genitalia. — The seminal vesicles were both firm and large. The testes were soft and yellowish, and microscopically showed some atrophy. There was no evidence of invasion in the seminal vesicles or in the testes.

The anatomical diagnosis was "leiomyosarcoma of the prostate, bilateral hydroureter, bilateral pyonephrosis, cholelithiasis, emphysema, and bronchopneumonia.

3. HODGKIN'S DISEASE OF THE PROSTATE

Enlargement of the prostate with characteristics resembling Hodgkin's disease. A most interesting and apparently unique case of new growth of the prostate in a young man aged 32 years was operated upon by the author at the Brady Foundation of the

New York Hospital some years ago, and diagnosed by the pathologist as enlargement of the prostate with characteristics resembling Hodgkin's disease. No other case like it has been found in the literature. The patient had a definite lymphocytosis, a moderate anemia of the chlorotic type, enlargement of the chain of inguinal lymph nodes on each side, loss of weight and strength, impaired appetite, and the general appearance of a tubercular person — all associated with marked enlargement of the prostate, acute retention, and urinary symptoms of only 3 months' duration.

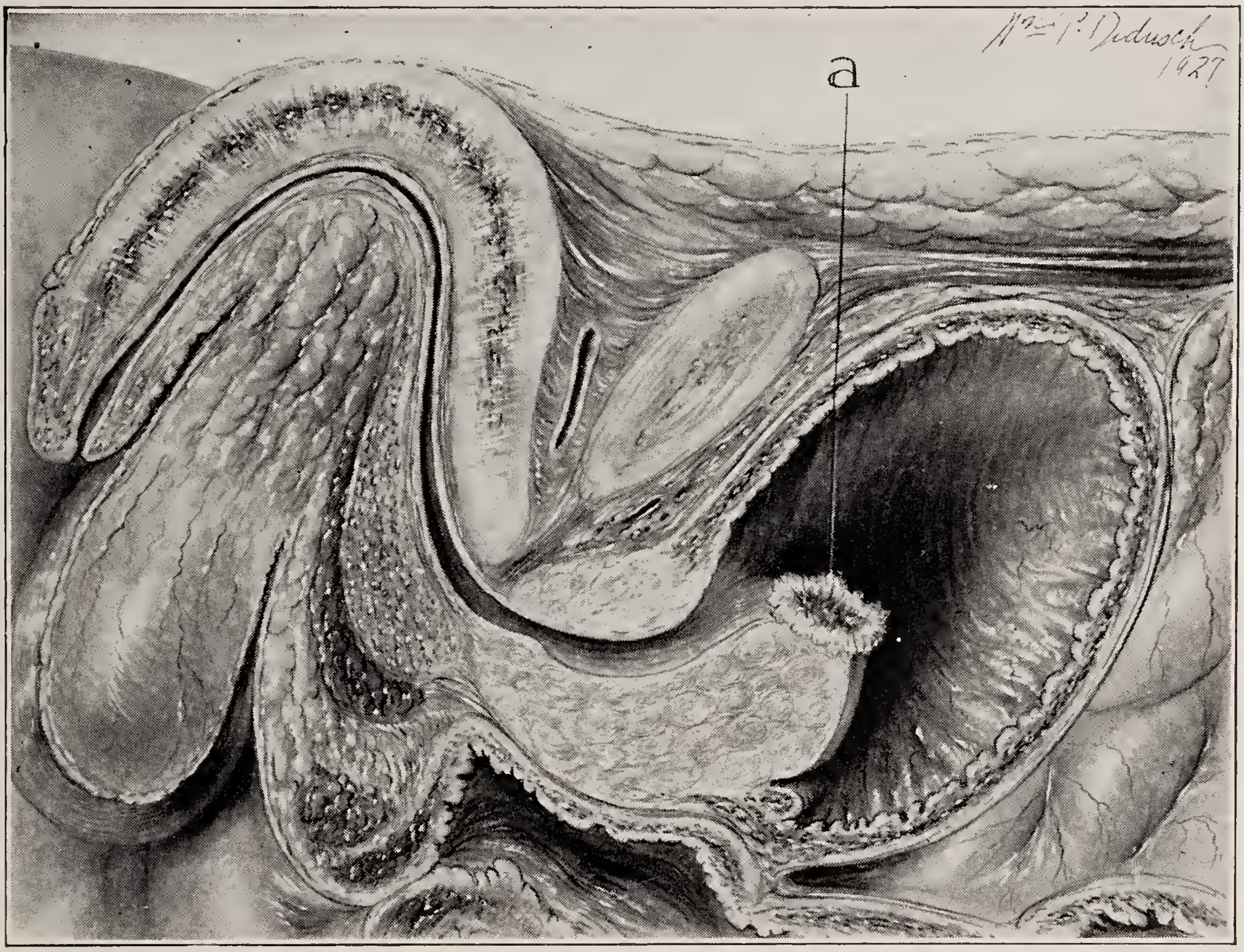

Fig. 35. Enlargement of the prostate gland, with characteristics resembling Hodgkin's disease, in a man 32 years old. Sagittal view of urethra, prostate, and bladder showing massive enlargement of the prostate gland, from which a piece has been removed (a) which showed characteristics resembling those of Hodgkin's disease. (Courtesy of Annals of Surgery.)

Hodgkin's disease (malignant granuloma; lymphogranulomatosis), when fully developed, shows a highly characteristic histological picture which enables one to make a positive diagnosis. Frequently, however, this picture is not fully developed and the histological diagnosis then becomes less certain. While the case described here belongs to this latter group, as is evidenced by the pathologist's report, its unusual features merit its detailed description. The presence of plasma cells and Sternberg giant cells point to Hodgkin's disease, which starts in certain lymphoid tissues and spreads to other lymphoid structures, leading to a general lymph-node enlargement that is always fatal. The localization of the process at the bladder neck is, however, most unusual in Hodgkin's disease.

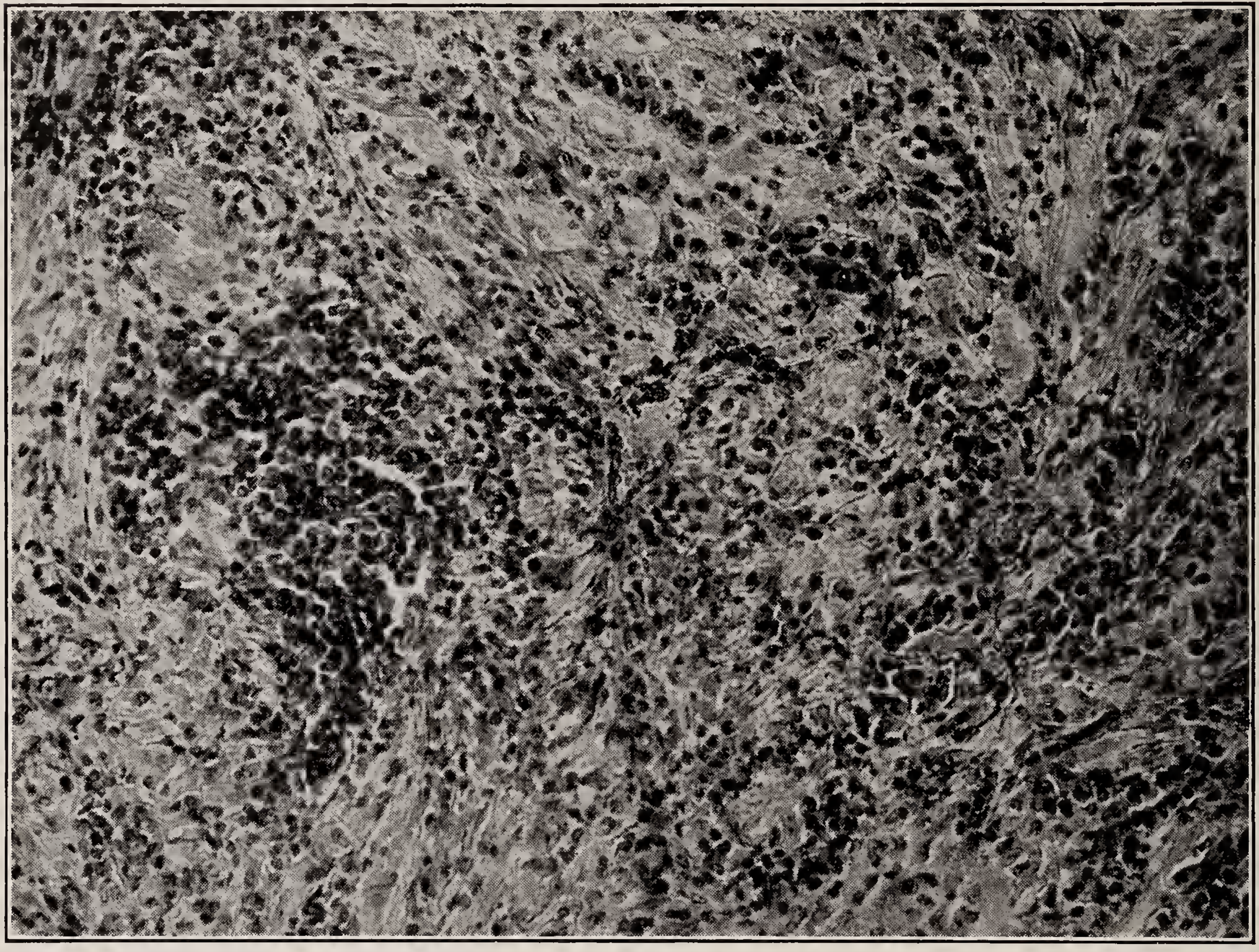

Fig. 36. Enlargement of the prostate with characteristics resembling Hodgkin's disease. Photomicrograph of a section through the prostate, showing characteristics of a granuloma. The plasma cells, eosinophiles, and Sternberg giant cells point to Hodgkin's disease. (Courtesy of Annals of Surgery.)

A single man, aged 32 years, was admitted to the Medical Service of Dr. Lewis Connor (New York Hospital) on December 7, 1926 with acute retention, and was transferred to the Urological Service on December 11. He stated that his father had died at the age of 59 years from cancer of the liver, and his mother at the age of 28 years from pulmonary tuberculosis. He had one brother and two sisters, all living and well. He had had pneumonia and mumps 14 and 10 years earlier, respectively; denied syphilis and gonorrhea by name and symptoms; and stated that he had been a chronic drinker, but for the past 4 years had not touched liquor.

Three months before his admission to the hospital, he had developed a moderate diurnal and nocturnal frequency of urination, which progressively grew worse and was associated with painful and difficult urination. He had noticed no pus or blood in his urine. His sexual powers were undisturbed. Three days before admission, he was unable to void except with the utmost pain and difficulty. He finally developed acute retention and was brought to the hospital in an ambulance. His bladder was decompressed gradually by means of a retention catheter.

The patient seemed to be fairly well nourished and in moderately good health, although he stated that he had lost 20 pounds in weight in the last 6 months, and during the past 3 months had grown progressively weaker but had not been confined to his bed. He had no cough. His bowels moved regularly. His appetite was somewhat impaired. He did not suffer from insomnia, but grew dyspneic on slight exertion.

His general physical examination was negative except for moderate bilateral enlargement of the inguinal lymph nodes and a small fibroma on the inner aspect of the left thigh. The lower poles of both kidneys could be felt, as well as the distended bladder. Rectal examination revealed the prostate to be about twice the usual size. The right side was hard but did not have the boardlike rigidity of carcinoma; the left side seemed normal in consistency and not fixed in position by adhesions. The left seminal vesicle was palpable but not enlarged, the right barely palpable.

Cystoscopy, under caudal anesthesia, revealed a diffusely reddened bladder fundus. The ureteral orifices were not distinctly seen. The vesical orifice showed a tremendous intrusion of the subcervical group on its floor.

Roentgenograms of the genito-urinary tract revealed both kidney shadows large in size and low in position.

Examination of the urine showed: acid reaction, specific gravity 1018, a trace of albumin, no sugar, no acetone. Microscopic examination showed many red blood cells, a few white blood cells, occasional epithelial cells, no crystals, no casts. Cultures of the bladder urine revealed *Bacillus coli communis* and *Staphylococcus albus*. The phenolsulphonphthalein test showed a secretion of 60 per cent. in two hours at one examination and 75 per cent. at another.

The blood urea nitrogen was 17 mgs. per 100 cc.; blood sugar 0.112 per cent.; carbon-dioxide-combining power of the blood plasma 56 volumes per cent. The blood Wassermann was negative on two examinations. A complete blood count was made on two occasions, with the following results:

	12/8/26	1/9/27
Red cells	5,112,000	4,815,000
Hemoglobin	93%	88%
Color index	0.91	0.92
White cells	8,600	7,400
Polymorphonuclear neutrophiles	54%	48%
Lymphocytes	38%	44%
Large mononuclears	6%	7%
Eosinophiles	2%	3%
Blood pressure on entrance to hospital	114 systolic	62 diastolic

Suprapubic cystostomy was done under local anesthesia. Examination of the interior of the bladder revealed a rather firm mass, about the size of a walnut, extending from the floor of the bladder neck. A specimen was taken from this tumor-like projection for biopsy (Fig. 35). The bladder was drained by suprapubic suction for 14 days, after which the prostate was removed suprapubically under sacral and parasacral anesthesia. The growth had greatly increased in size in the two weeks since the first operation. The site whence the biopsy specimen had been removed showed a very irregular cauliflower-like overgrowth. Malignancy was suspected. The prostate was removed completely except for one point on the left lateral aspect, where it was densely adherent and the growth apparently had infiltrated the prostatic capsule. The patient had an uneventful recovery and was discharged 14 days after prostatectomy, with the wound completely healed and good urinary control.

The pathologist's report was as follows: "The specimen consists of several irregularly shaped pieces of tough tissue measuring from 1 to about 4 cm. in diameter. The cut surface appears yellowish-white, somewhat translucent, with opaque yellowish strands running through a whitish matrix. The gross picture is not that of a carcinoma nor does it resemble normal prostatic tissue. The microscopic examination shows the picture of a chronic inflammatory process. The granulomatous newly formed tissue is rich in plasma cells and contains mononuclear giant cells of the Sternberg type, and also eosinophilic leukocytes. While these features are suggestive of Hodgkin's lymphogranuloma, the evidence available is not sufficient to make a diagnosis of the disease."

An inguinal lymph node was removed and examined. Microscopic sections showed simple chronic lymphadenitis, with no evidence of a granulomatous process like that seen in Hodgkin's lymphogranulomatosis.

The small tumor on the inner aspect of the thigh showed, on microscopic sections, the picture of a fibroma durum covered by stratified squamous epithelium.

PROSTATIC CALCULUS

Incidence. The subject of prostatic calculus has received serious consideration only during the last quarter century. Previous to 1914, when Glaesel published the first real review of the subject and collected 54 cases, prostatic calculi were regarded as medical curiosities and of no clinical importance. Although Marcellus Donatus described a case of prostatic stone as early as 1687, only a very few cases were reported during the next two centuries, and even in the first decade of the present century such eminent urologists as Legueu and Marion expressed doubt as to the existence of true prostatic calculi. In 1918, Kretschmer exhaustively reviewed the literature and reported a total of 178 cases, including 8 from his own practice. Nine years later, he reported 76 personally observed cases, ascribing this great increase to routine roentgenograms. Approximately 425 cases had been reported up to 1938 (Lowsley and Hawes).

Many prostatic calculi produce no symptoms, and are only discovered accidentally in the course of a routine examination, or during operation for some other prostatic condition, or at autopsy. It is not unusual to encounter unsuspected calculi when sectioning an hypertrophied prostate for microscopic study. In a study of over 250 prostates from subjects of all ages, obtained in routine necropsies at Bellevue Hospital (New York), the author found one or more of these concretions embedded in approximately one-fifth of the glands.

" True " and " false " calculi. A distinction must be made between (1) " true ", or endogenous, calculi — namely stones formed within the prostatic substance, and (2) " false ", or exogenous, calculi — concretions that have either formed in the kidney, ureter, or bladder and lodged in the prostatic urethra, or have formed primarily from urinary sediments in a pouch communicating with the prostatic urethra.

" True " prostatic calculi vary considerably in size, as well as in the number present in a single gland and the manner in which multiple stones are distributed. Usually they are multiple, small, rounded, dark brown in color, and scattered indiscriminately throughout the parenchyma of the gland. Occasionally there will be found a single large calculus, or one large stone in association with multiple small concretions elsewhere in the gland, or a cluster of small calculi in one lobe with none in the remaining lobes. Nicolich reported a case in which the stone measured 9 by 10.5 cm. and weighed 320 grams. The largest number of calculi found in any one prostate — 1,247 small concretions — was reported by Rovsing. The author found 325 stones in the prostate of a patient who complained only of difficulty in urinating. Another of our patients had a collection of 125 stones.

The nucleus of a " true " prostatic stone is formed of organic material of an albuminoid nature, but not a true protein. It may consist of corpora amylacea, a blood clot, epithelial detritus, a clump of bacteria, or necrotic tissue resulting from an abscess. The inorganic material forming the laminated layers about the nucleus is composed of inorganic salts such as calcium phosphate, magnesium phosphate, amino-magnesium phosphate, potassium phosphate, calcium oxalate, and calcium carbonate. " True " and " false " stones, as was pointed out by Kretschmer, may have outer coverings of similar composition, so that the differentiation between them must rest upon chemical analysis of their nuclei —

the nuclei of the latter being composed of urates and earthy phosphates.

Etiology of prostatic calculi. The exact etiology of "true" prostatic calculi is undetermined. Of the many theories that have been advanced to explain their formation the most generally accepted is that expounded by Sir Henry Thompson in 1868. He maintained that they have their origin in corpora amylacea, which, after attaining the size of the prostatic acini enclosing them, act as foreign bodies and set up an inflammatory reaction in the mucous membrane of the acini, as a result of which calcium phosphate and carbonate are cast off; these are deposited upon the corpora amylacea, converting them into prostatic calculi. Young believes that they arise by depositions from the secretion present in the ducts, just as calculi in the urinary tract arise from urine.

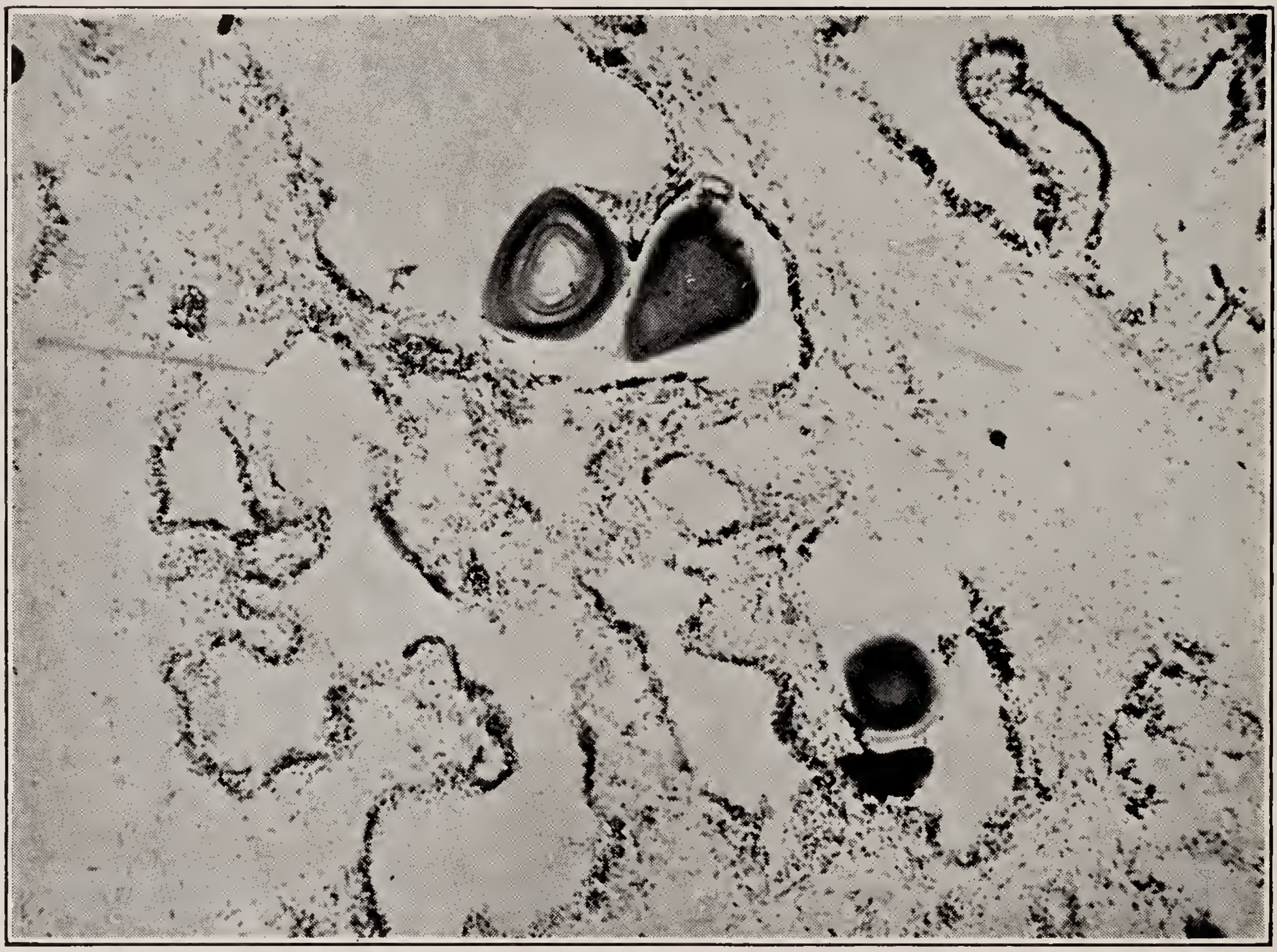

FIG. 37. Photomicrograph (low power) showing several corpora amylacea in prostatic tubules. Corpora amylacea form the nuclei of many prostatic calculi. When they have attained the size of the prostatic acini enclosing them, they act as foreign bodies and set up an inflammatory reaction in the mucous lining of the acini. This results in the casting off of calcium phosphate and carbonate, which are deposited upon the corpora amylacea, converting them into calculi.

Many observers are of the opinion that prostatic calculi result from a pre-existing chronic prostatitis; others, that they result from a pre-existing prostatitis complicated by benign hypertrophy. Almost all prostates containing symptom-producing stones show some evidence of infection; but whether such infection is primary, or is secondary to the calculus formation, is difficult to say. Benign hypertrophy and prostatic calculosis are frequently associated, but in many other cases there is no sign of hypertrophy. Sometimes a calculi-containing prostate may be senile and fibrotic, with atrophy of the parenchyma and evidence of inflammation. When calculosis and benign hypertrophy do occur together, the calculi are found not within the hypertrophied area, but between it and the capsule, embedded in the remnants of the true prostate. In these cases, the concretions probably form in the parenchyma of the prostate and simultaneously, or later, the adenoma develops from the periurethral glands and, as it gradually enlarges, forces the stones toward the capsule.

It is probable that calculi of the prostate gland, like those found elsewhere in the body, are attributable not to a single predisposing factor, but to a variety of causes.

Pathology. Microscopically the portion of the prostate containing the calculi shows distended acini, the mucosal linings of which are infiltrated by lymphocytes or polymorphonuclear leukocytes. There is an increase in the interacinar fibrous connective-tissue stroma.

Symptoms and diagnosis. Prostatic calculi may be found at any period of life, but they are rare in childhood and youth and most frequent between the ages of 40 and 70 years.

Calculi may be present in the prostate for long periods of time without producing symptoms. Many are discovered accidentally, during routine examination, operation, or postoperative or postmortem sectioning of the prostate. In other cases the symptoms are overshadowed by those of an associated prostatitis or hyperplasia.

When symptoms do occur, they are not pathognomonic. The most common symptoms are the usual urinary manifestations of bladder-neck obstruction: diurnal and nocturnal frequency, burning on urination or dysuria, urgency, hesitancy, retention, and occasionally dribbling and incontinence. Less frequent manifestations are hematuria, pain in the perineum, suprapubic region, rectum, or along the penile shaft, loss of sexual power, and the actual passage of calculi either spontaneously or following prostatic massage. Evacuated calculi are readily confused with urinary stones, and no doubt often pass wholly unnoticed as they are seldom large enough to cause obstruction.

A presumptive diagnosis of prostatic calculi may frequently be made by the rectal palpation of a markedly indurated gland almost stony hard in consistency, or a circumscribed hard area suggestive of a stone or nodule. Again, one may elicit crepitation by palpation, especially when the calculi occur in groups. The positive diagnosis of prostatic calculosis, however, depends upon properly taken roentgenograms — all of these concretions being of the shadow-casting type. Cysto-urethrograms are of value not only in revealing the calculi, but in determining the type and degree of obstruction to urination and, if benign hypertrophy is present, its extent.

The conditions most likely to be confused with prostatic calculosis are prostatic carcinoma, tuberculosis, and nodular hypertrophy. The coexistence of prostatic carcinoma and calculosis is unusual, but does occur. Sometimes the calculi-containing prostate is enlarged and somewhat boggy in consistency owing to concomitant chronic prostatitis, and it may then be confused with prostatic abscess.

Treatment. Very small, asymptomatic prostatic calculi, which are discovered accidentally during routine examination, are best left alone. Removal through the urethroscope, and attempted liberation and evacuation by prostatic massage have seldom proved of lasting value, recurrence being very common. However, any stone in the prostate is a source of potential danger, and these patients should be examined at intervals. When symptoms of infection and obstruction occur, and are found to be due to the presence of calculi in the prostate, surgical intervention becomes necessary (see Operative Treatment of Prostatic Calculus).

INJURIES TO THE PROSTATE GLAND

Etiology. The prostate gland may be injured (1) by external traumatism, (2) during urethral instrumentation, or (3) during surgical operation.

Injury to the prostate from external traumatism is rare, due to its protected location. Occasionally the gland may be involved in gunshot injuries; or punctured, incised, or lacerated wounds may be inflicted on it, as in falls astride some pointed object which pierces the perineum and reaches the prostate. Ordinarily, the pubic and ischial rami protect it from injuries such as befall the urethra below and the bladder above. Although accidents frequently bring violent force to bear upon the perineum, the tissues of the anoperineal region and the ischiorectal fossa are so elastic that they act as a sort of musculo-cellular cushion which takes the force of the violence and thus protects the prostate. Sometimes the prostate, together with the surrounding structures, is seriously traumatized in severe fractures of the pelvis; and in rare instances the gland may be pierced by a fractured pelvic bone when the adjacent tissues are not greatly damaged.

Injury due to careless or unwise instrumentation is considerably more frequent. It is not uncommon to see a false passage coursing through the prostate which has its commencement in the prostatic urethra or somewhere in the urethral wall anterior to the apex of the gland. The cause of these false passages is usually enlargement of one or more of the prostatic lobes or a urethral stricture, which renders the shape of the urethra so irregular and abnormal as to make the proper passage of a catheter or other instrument extremely difficult. Even with a normal prostate and urethra the gland may suffer injury, particularly if the instrument used is small and pointed. The urethra curves sharply in the region of the triangular ligament and a catheter may be impeded in the bulb, when the external sphincter is spasmodically closed, so that instead of traversing the route intended the instrument may pierce the wall of the urethra, pass through the periurethral tissues, and penetrate one of the prostatic lobes. The possibility of prostatic injury only emphasizes the need of care and the utmost gentleness in every maneuver of this kind.

Operative traumatism is also common. In practically all perineal procedures and operations at the vesical neck the prostate is more or less hazarded. Increased anatomical knowledge and improved operative technic have served to lessen these dangers considerably, but one should always bear in mind the possibility of such injury and make every effort to prevent its occurrence.

Signs and symptoms: diagnosis. The signs and symptoms of injury to the prostate vary greatly, depending on the extent and location of the injury and the complications. The complications most likely to occur are (1) hemorrhage, which may take place through the urethra or internally, into the bladder or pelvis; (2) extravasation of urine and blood into the adjacent tissues; (3) retention of urine, due to inflammatory occlusion of the urethra, or obstruction by blood clots, or to complete or partial obliteration of the canal; (4) incontinence of urine resulting from injury to the vesical sphincters.

Apparently slight injury due to a false passage may lead to extravasation and deep-seated infection. In extensive trauma of the prostatic substance, with rupture of the prostatic urethra, there will be bleeding from the urethra and extravasation of urine and blood, or urinary obstruction and distention of the bladder with urine and blood clots. Septic cellulitis and abscess, possibly followed by urinary fistula, are serious sequelæ of severe injuries to the prostate, especially when drainage is imperfect. The cellulitis may be limited to the anoperineal region and ischiorectal fossa, or it may extend over a large area of the subcutaneous and intramuscular planes of cellular tissue. If the wound extends beyond the bounds of the prostate, septic pelvic cellulitis or general peritonitis may develop. It will be noted that the dangers to which the victim of prostatic injury is subjected are, in general, the same as those which characterize trauma to the bladder or urethra.

The history is of diagnostic importance. A history of urethral instrumentation, followed by a chill, hemorrhage, and difficulty of urination is suggestive. So, also, is a history of fracture of the pelvis or other severe external trauma, followed by difficulty in urinating, or complete retention, hemorrhage, and symptoms of extravasation.

Treatment of prostatic injuries. Instrumental injury, with mild symptoms, frequently requires no treatment other than cessation of instrumentation and observation of the patient. In more severe injuries, treatment is directed to the control of hemorrhage, the restoration of normal urinary function, and, if extravasation has occurred, to the complete drainage (both perineal and prevesical) of the extravasated areas. When the injury to the prostate is from an external source, more important injuries to other structures are usually present which must be attended to first. Rupture of the urethra and later sequelæ, such as strictures, fistulas, and incontinence of urine, must be treated surgically as a rule.

SURGERY OF THE PROSTATE GLAND

ANESTHESIA IN PROSTATIC SURGERY

Anesthetics of choice. The question of anesthesia is of the greatest importance in prostatic operations, the majority of which are done upon elderly men with complicating cardiovascular lesions and more or less renal impairment.

General inhalation anesthesia, as a complete anesthetic, is undesirable — in many cases prohibited — in prostatic operations, despite the great advances that have been made in this field in recent years. There are several reasons for this: (1) General inhalation anesthesia requires that fluids must be withheld for varying periods of time both before and after operation. Certain general anesthetics cause nausea and vomiting, which not only prevent the ingestion of fluids after operation but also deplete the fluid content of the body by expelling the stomach contents. Therefore, any form of anesthesia which causes nausea and vomiting is undesirable. (2) Every type of inhalation anesthesia elevates blood pressure. The extent of this elevation varies in individuals, in the type of anesthetic agent used, and in the method of administration. This elevation of blood pressure results in much more bleeding than is experienced under regional anesthesia. (3) When electrically connected instruments are employed — which is frequently in prostatic work — the use of an explosive gas is, of course, impossible. If the surgeon feels that general inhalation anesthesia as a complete anesthetic is necessary, cyclopropane is the first choice (except when electric devices are employed) on account of the rapid, smooth absorption and induction, and because of the relaxation it affords without increase in oxygen-want. Nitrous oxide can be safely used when electric instruments are employed but has certain disadvantages, namely the inadequate muscular relaxation it affords, the length of time required for induction, a struggling patient, and the danger of anoxemia in a patient already in oxygen-want.

General inhalation anesthesia, as a supplement to regional anesthesia, has a definite place in prostatic surgery. Here, also, cyclopropane is the first choice when electric instruments are not used, and nitrous oxide when they are.

Regional anesthesia in some form (usually low spinal, or sacral and parasacral) is the method of choice in the majority of operations upon the prostatic gland. The reasons for this preference are: (1) its greater safety (there is little disturbance of blood pressure and, consequently, much less bleeding, less shock, and a lower mortality than with general inhalation anesthesia); (2) the complete muscular relaxation afforded; (3) the fact that the patient may take fluids up to, during, and immediately after operation;

(4) the drier operative field made possible by the decreased bleeding; (5) the fact that it can be safely used when the electrocautery or high-frequency current is employed. Another distinct advantage that regional anesthesia, with a conscious patient, offers is the early detection of pain and shock following rupture of the bladder or extravasation of urine during transurethral resection. Disadvantages of the regional methods are: (1) inability to eliminate the agent in an emergency, and (2) a conscious patient. Regional anesthesia is especially indicated in patients with renal and cardiac impairment, diabetics, and those with pulmonary tuberculosis or other active disease of the respiratory tract.

For perineal prostatectomy and transurethral resection, in the better risk cases, low spinal anesthesia, using procaine hydrochloride, pontocaine, or nupercaine in low dosages (60 to 120 mgm. procaine) is safe and satisfactory. In old patients and those who are essentially poor risks, sacral and parasacral anesthesia is preferred by many surgeons. From 50 to 60 cc. of a 1 per cent. solution, or 30 cc. of a 2 per cent. solution of procaine, caudally, plus injection of the sacral foramina (2 to 3 cc. each) is usually effective. If, on account of failure or partial anesthesia, supplementary anesthesia is required, nitrous oxide or intravenous anesthesia with pentothal sodium may be used in the presence of the electrocautery or high-frequency current. In perineal prostatectomy, explosive gases may be added. For suprapubic prostatectomy in younger patients and those who are considered good risks, we prefer low spinal anesthesia, utilizing a low to moderate dosage of procaine hydrochloride (60 to 120 mgm.) and, if necessary, supplementing it with a general inhalation anesthetic. For elderly patients and those with cardiovascular lesions, *local infiltration anesthesia* (with 1 per cent. procaine), supplemented with cyclopropane or ethylene, is preferred.

Intravenous anesthesia, with pentothal sodium (usually in a 5 per cent. solution), is often used to supplement regional block, particularly when electric devices are employed. Fractioning the dose is considered less dangerous than injecting the entire amount at one time, for the individual reaction to this drug varies greatly. Evipal sodium is today used much less frequently than pentothal. It is absolutely contraindicated when vascular or cardiac lesions are present, resulting in respiratory or circulatory disturbances.

Spinal anesthesia. Spinal anesthesia is distinctly advantageous for the diabetic since it causes less disturbance in the level of the blood sugar, and does not cause acidosis. Unless marked, hypertension is not usually a contraindication to its use. Low blood pressure (systolic pressure under 100 mm. Hg.), on the other hand, is a strong contraindication, as are coronary disease, cerebrospinal lues, anemia (hemoglobin less than 50 per cent.), and severe shock.

The drug most frequently used is novocaine (procaine) hydrochloride. In the author's service we use novocaine crystals as a rule; also pontocaine and occasionally nupercaine. The dosage depends upon the weight of the patient, the type of operation, and the length of time anesthesia is desired. Low dosages (60 to 120 mgm. procaine) are usually safe and satisfactory, since body metabolism is unaltered as a rule and therefore shock is not produced. With proper technic, perfect relaxation is obtained and postanesthetic complications avoided.

Many anesthetists routinely inject adrenalin before the anesthetizing drug is injected. It is our practice to administer ephedrin hydrochloride, 5 per cent. (0.05 gram) in the preanesthetic injection, reserving the use of adrenalin until there is evidence of a rapid decrease in the blood pressure. If injection into the deep muscles of the gluteal region does not have the desired counteracting effect, adrenalin may be employed in the form of an infusion. This should be prepared in advance and kept in readiness whenever spinal anesthesia is administered. The usual proportion is 1 minim of 1:1,000 adrenalin to each 100 cc. of normal saline. Adrenalin is a powerful heart stimulant and vasomotor constrictor, and should be used only in high dilution, allowed to run in very slowly, and the infusion stopped the instant the desired effect has been obtained.

Technic of Administration. Adequate preliminary medication is particularly important in regional anesthesia. The barbiturates and opiates are very satisfactory for this purpose. The barbiturates given at bedtime not only secure the patient a night of restful sleep, but act as an antidote to the toxic effects of the agents used in regional anesthesia. Amytol, nembutal, and tribromethanol prevent hyperactivity of the sympathetic nervous system. Nembutal (in doses of 1 capsule, or 0.1 gram, at bedtime and 1 or 2 capsules 45 to 60 minutes before operation), with or without morphine (0.01 to 0.015 gram) or pantopon (0.01 to 0.02 gram), and atropine sulphate (0.0003 to 0.0004 gram) is very effective. Phenobarbital (0.1 gram at bedtime and 0.2 gram 1 hour before operation) is also satisfactory.

Spinal anesthesia is often administered with the patient in the sitting position. The anesthetizing drug may also be injected with the patient lying on his side, with knees flexed, head bent forward, and back curved outward; this separates the spinous processes and permits easy and painless puncture.

For operations upon the prostate gland or bladder, the injection is usually made in the second lumbar space; and for operations upon the urethra or perineum in the third lumbar space.

The skin at the point of puncture is sterilized with iodine, 3.5 per cent., sponged off with alcohol, 70 per cent. A 1 per cent. solution of procaine is injected subcutaneously by the anesthetist before the spinal puncture is made. (In our practice, ephedrin hydrochloride, 5 per cent. (0.05 gram), is administered in this preanesthetic injection.)

When the spinal needle (22 gauge, 9 cm.) is in place, the stylet is withdrawn. The spinal fluid will then drip from the needle and is caught in the ampoule containing the novocaine crystals, thereby dissolving the crystals and making a solution for injection. The solution is withdrawn from the ampoule by means of a 22 gauge, 5 cm. needle. This needle is then removed from the syringe, the syringe attached to the spinal needle, and the solution reinjected through the same puncture. The action of a drug thus introduced is very rapid, and the operation can usually start as soon as the patient can be transferred to the operating table and prepared.

Following the injection of the anesthetic drug the patient should be placed in an 8 to 10-degree Trendelenburg position. Moist gauze or towels should be placed upon his face. The blood pressure should be taken every five minutes, particularly during the first part of the operation. Oxygen is administered throughout, except when the patient complains of nausea or other abdominal symptoms are in evidence. Should these occur, the oxygen administration should be stopped and the patient instructed to take 10 or 12 deep breaths through the mouth, which usually will clear up the nausea and permit the continuation of the oxygen administration.

If anesthetic shock occurs — that is, if the blood pressure falls abruptly during the first minutes of anesthesia — this must be controlled with oxygen inhalations, the use of the Trendelenburg position, and injections of coramine (1.5 to 3.0 cc. intramuscularly or intravenously), or adrenalin, 1:1,000 (0.5 to 1.0 cc.). Shock due to idiosyncrasy to novocaine is usually quickly controlled by artificial respiration with carbon dioxide and oxygen, and the intravenous administration of ephedrin.

Sacral and parasacral anesthesia. Sacral and parasacral anesthesia is very useful in operations upon the prostate, especially in old patients and those who are essentially bad risks. With the proper type of patient, it is safe, devoid of complications, and effective, if the correct amount of anesthetic and technic is used and the operation not started too early. If necessary, the effects may be augmented by either local infiltration anesthesia or intravenous anesthesia using pentothal sodium. Disadvantages of the method are (1) the time required for injection and the onset of anesthesia, and (2) the occasional incomplete or unsatisfactory anesthesia obtained.

The drug used in the author's service is freshly prepared procaine in a 1 or 2 per cent. solution. No adrenalin is used because we believe it increases the toxicity of the solution without any compensating advantages. Injection is done with a 20-gauge needle 9 cm. long, having a special point with a 45-degree angle and a fitted stylet.

Technic of Administration. The patient is given sedative medication the night before and again one hour before the operation, as described under spinal anesthesia.

He is placed on the table, resting on his abdomen or upon the knees and elbows. The skin at the point of puncture is sterilized with iodine, 3.5 per cent., sponged off with alcohol, 70 per cent. It is then infiltrated with procaine, 1 per cent.

The anesthetist palpates the coccyx and, sliding his finger above this bone, reaches the lower part of the sacrum, where he is usually able to palpate the sacral hiatus without difficulty. The sacral horns approximate the lateral borders of an imaginary triangle of which the hiatus is the apex. A 20-gauge needle, 9 cm. long, is inserted through the anesthetized skin and into the sacral canal by puncturing the ligament which covers its lower end. After penetrating this ligament the needle is easily pushed in 4 to 5 cm. The needle must be deflected and guided very carefully so that it will not impinge upon the bone. The operator soon learns to tell whether or not the needle is in the canal by the ease with which it passes and the direction which it takes. Also, if it is improperly inserted, the tissues at the end of the needle will be infiltrated with solution as soon as the injection is started. When the needle is in the canal, its end should be carefully observed to see if either blood or spinal fluid runs out. If so, the needle is withdrawn to a point where the blood or spinal fluid ceases to appear, and the injection made very slowly. If the solution runs in easily from the syringe, the operator may be sure that the needle is in the canal. If, however, the injection is made with difficulty, he may be sure that the needle is not in the canal, and the tissues over the sacrum should be observed for evidence of infiltration.

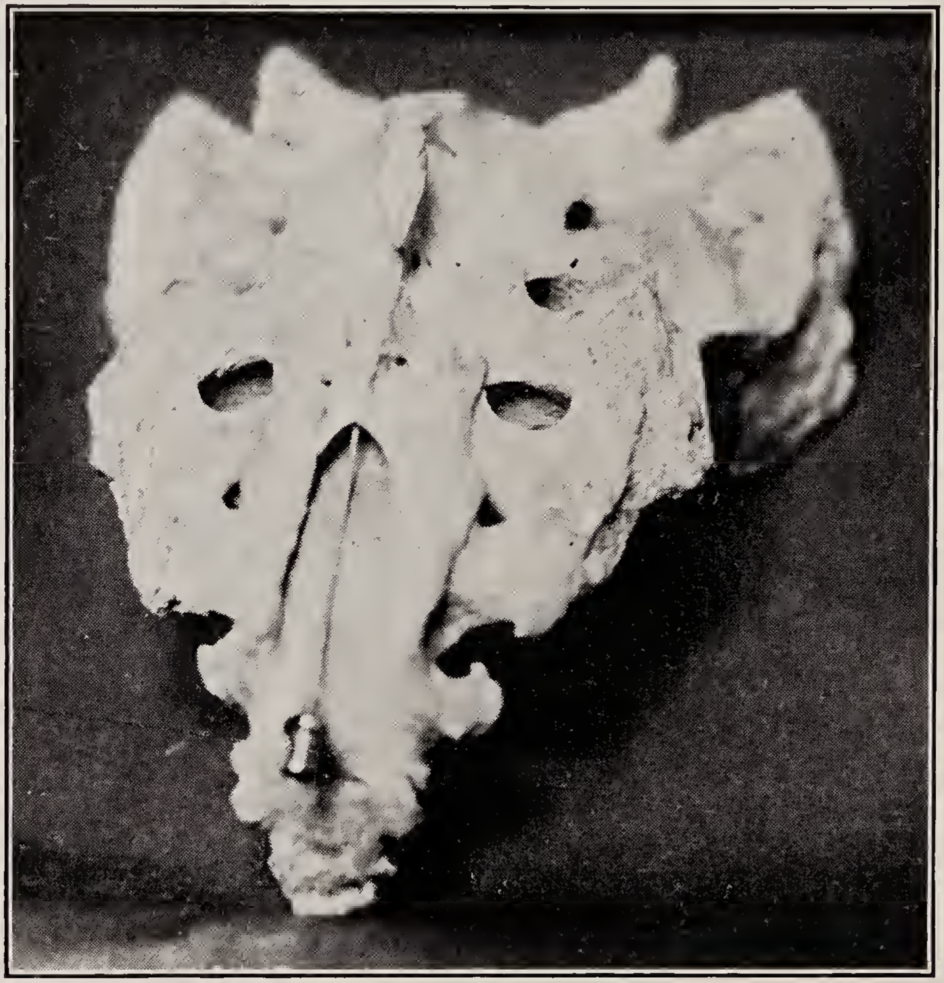

Fig. 38. This sacrum shows the hiatus of the canal higher up than normal. The needle inserted into it must not extend higher than the second sacral foramen, otherwise there is a possibility of puncturing the dura. Great variation was noted in the 250 specimens studied. One specimen had no roof whatever. Another was so contracted that, even in the dry state, a needle could not be introduced into its lumen.

From 50 to 60 cc. of a 1 per cent. solution, or 30 cc. of a 2 per cent. solution of procaine is usually injected into the canal.

Some or all of the sacral foramina (first, second and third on each side) are next injected with procaine solution. Three to 5 cc. of a 1 per cent. solution, or 2 to 3 cc. of a 2 per cent. solution should be injected into each foramen, the needle being slowly withdrawn so that the solution is distributed throughout the entire length of the foramen.

The patient is then placed on his back and fully 30 minutes allowed to elapse before the operation is begun. By this time, the buttocks, scrotum, urethra, and base of the bladder should be thoroughly anesthetized; otherwise the injection is unsuccessful.

OPERATIVE TREATMENT OF BENIGN HYPERPLASIA OF THE PROSTATE GLAND

Indications for prostatectomy. Not all patients with benign hyperplasia of the prostate gland require surgery. If there is only slight enlargement, with very little obstruction, palliative and expectant treatment should be tried (see Treatment of Hyperplasia of the Prostate, p. 746 (74)). In general, surgery is indicated (1) in the presence of residual urine which is not relieved by palliative treatment, (2) in cases of enlargement, without residual urine, where there is evidence of absorption of pus from the gland, and (3) if there is uncontrollable pain.

Selection of operation. Benign hyperplasia of the prostate is today treated by three methods of approach: the perineal, the suprapubic, and the transurethral. The choice of operation is of great importance. No two cases of prostatic hypertrophy are precisely alike, and each case must be considered individually and the method selected which seems best suited to the particular circumstances. In every case the aim of operative intervention should be to restore urination to a condition approaching the normal, eliminate residual urine and back pressure, and clear up infection. The day is past when the urologist could perfect himself in the technic of one particular method of prostatic removal, disregarding the claims of the others. It has always been the author's contention that every well-trained urological surgeon should be psychologically and technically equipped to perform any operation in urology. To that end, we train our students in the proper technic of perineal (conservative and total), suprapubic, and transurethral prostatectomy, each of which has its place in prostatic surgery. By limiting his surgery to one of these methods the operator limits his usefulness to his patients.

The ordinary suprapubic and perineal operations are both highly technical procedures. In the hands of experts the functional results are about equal. The chief reason for the popularity of the so-called Fuller-Freyer suprapubic operation is that the surgeon can carry it out with little assistance, whereas the proper performance of the perineal procedure requires the coöperation of a highly trained surgical team. Also, as cystostomy often precedes prostatectomy, the idea of making a single incision serve for both stages of the intervention appeals to both surgeon and patient. However, unless there is some excellent reason for taking out the prostate suprapubically, it is, in the author's opinion, preferable to perform the perineal operation in most instances of great enlargement of the gland because, while it requires more time and a thorough knowledge of the anatomy of the region, it is not so likely to induce shock. Shock is more apt to accompany intervention by the upper route because there is always more or less pressure on, and traumatism to, the complicated nervous plexuses over which the work must be done. The possibilities of gravity drainage, together with the fact that the patient is usually able to sit up in a chair by the third or fourth postoperative day — a great advantage in aged patients especially — are additional arguments in favor of the perineal operation along the technical lines established by Young and modified by the author and others.

Modern transurethral resection is a development of the past two decades. Its evolution during that period has been accompanied by widespread interest on the part of both the medical profession and the laity. Particularly during the first decade of its employment, many extravagant claims were made regarding the "simplicity" of this method and its efficacy in removing all types and sizes of enlarged prostates without the preliminary preparation of the patient which has reduced the mortality of the open operation from nearly 50 per cent. to about 6 per cent. One great harm done by its too ardent protagonists was that their claims gave every doctor who could manipulate a cystoscope the idea that he could perform the transurethral operation. Such, of course, was not the case, and the high mortality of these amateur surgeons did much to hinder the proper development of an excellent method. While some urologists, in their enthusiasm, even went so far as to attempt to replace perineal and suprapubic prostatectomy by the newer method, others went to the opposite extreme and sought to discredit the operation because of the frequency of recurrences, and the serious complications — infection and sepsis, traumatic stricture, and persistent urinary dysfunction — which so often followed its performance.

With the passage of time and the accumulation of experience, it has been shown that neither of these extremes of viewpoint is justified. The scope and limitations of transurethral resection are now much better defined, and within the limits of its applicability — which are wide — its usefulness has been amply demonstrated. The method has won a permanent and prominent place in surgery of the vesical neck, but it is not a suitable method for routine use in all prostatic enlargements. The degree of its usefulness, like that of the other methods of prostatectomy, depends entirely upon the judgment and skill with which it is performed. Moreover, far from being a "simple" operation, it has been found to be a highly technical procedure and definitely as much of an expert's operation as perineal or suprapubic prostatectomy.

Before deciding which operation to perform in a given case, one must determine the type and degree of enlargement present. This is done by digital investigation of the interior of the bladder at the time of preliminary cystostomy, or by cystoscopy in less serious cases.

It is our opinion that small, moderate, and even large median lobes and subcervical group enlargements are suitable for this type of surgery, and that the scope of the original Young punch has been enormously widened by the efficiency of the modern resectoscopes. Transurethral resection is also indicated for fibrous bars and contractures of the vesical neck; for temporary relief of obstruction at the vesical neck in certain cases of prostatic carcinoma, or in cases of benign hyperplasia in patients whose life expectancy is, for any reason, short. It has also proved a decided boon to patients who, because of age or serious organic derangements, cannot undergo open operation.

Extensive bilobe and trilobe enlargements, and massive median-lobe hyperplasias should be treated by open operation by either the suprapubic or perineal approach, depending upon the indications. The author considers it decidedly inadvisable to attempt transurethral resection by any method in the following circumstances: (1) if there is marked enlargement of both lateral lobes, even though the median lobe is not enlarged or is shrunken and sclerotic; (2) if there is massive median-lobe hypertrophy; (3) when the median and lateral lobes are so hypertrophied as to constitute a formidable mass of tissue. Removal of the gland by a transurethral method can only be considered as a coring process. It is absolutely impossible to remove all of a greatly enlarged prostate by any such method thus far proposed, due to the contour of the gland. Attempts to do this, therefore, are doomed to defeat from the beginning. Removal of as much prostatic tissue as possible leaves a cavity of greater or less size inside an elastic organ surrounded by a firm capsule. Before the patient has fully recuperated from the operative intervention in such a case, the remaining lobules of the gland will have been pushed into the hollowed-out tunnel by the contraction of the capsule, and this process will repeat itself indefinitely so that, after being operated upon repeatedly over a period of many months, the patient will still be subject to urinary obstruction by the ingrowth of prostatic nodules, if he lives long enough to encounter this eventuality. In other words, the urologist finds himself in the position of the olden-time tonsillectomist. After repeated resections, there is necessarily left considerable prostatic tissue which is sure to give trouble ultimately.

There are other reasons why massive hyperplasias should not be treated by transurethral resection: (1) The danger of extravasation at the time of operation and postoperatively is too great when large lateral lobes are removed, due to the thinness of the prostatic capsule ventrally and laterally. (2) The time required to remove such glands, extending up to two and one-half and three hours, is too shocking to the patient. (3) Incomplete removal of the devitalized tissue is likely to be followed by infarction over a considerable area, resulting in persistent urinary dysfunction and urinary sepsis. In regard to this last point, Nesbit — himself an advocate of transurethral resection whenever possible — states:

> Flocks has shown that most of the hypertrophic mass of tissue derives its blood supply from the urethral arteries, which enter the prostate in the region of the internal sphincter and course distally in the substance of the lateral lobe. In transurethral resections these vessels are cut across and thrombosed at their point of entry into the gland. If the tissue supplied by them is not removed at operation, it necessarily undergoes varying degrees of devitalization and may become infarcted throughout a considerable area. Patients harboring such septic infarcts may suffer recurrent obstruction, persistent abnormalities of urinary function, urinary sepsis and delayed hemorrhages. Their primary need for prostatectomy has not been supplied, and relief from the disability is dependent on the completion of the prostatectomy by either the transurethral route or some other. Thus the researches of Flocks, as well as clinical experience, have abundantly demonstrated that transurethral resection must be, in fact, transurethral prostatectomy. Surgeons who perform this operation must be sufficiently aware of their own technical limitations to employ it only when the gland is of such a size that more or less complete removal of the tissue can be expected.

The results obtained by the profession at large do not warrant the employment of transurethral resection upon the greatly enlarged prostate.

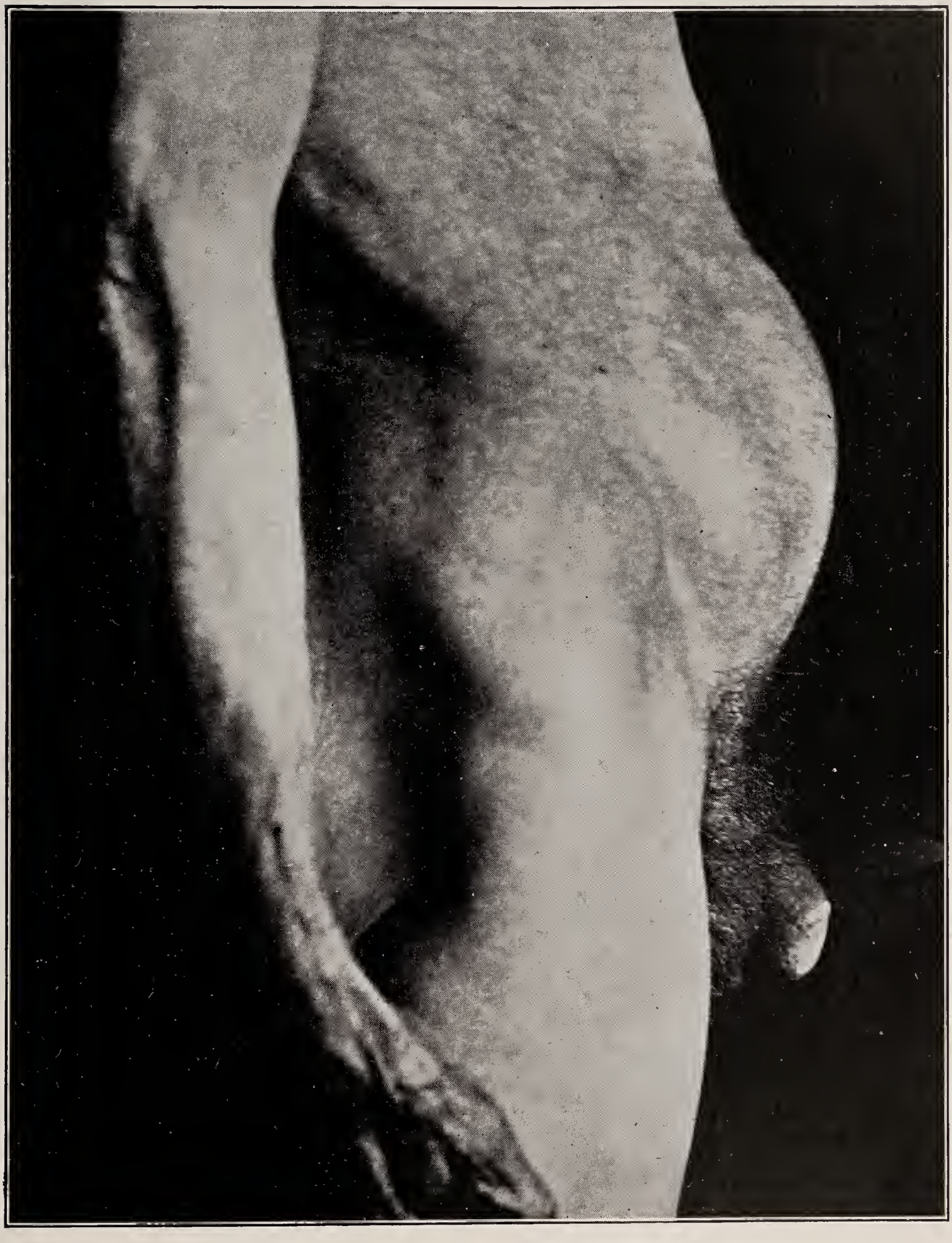

FIG. 39. Distended bladder in acute retention due to enlargement of the prostate gland.

In brief, then, it is our general practice to remove by means of transurethral resection all enlargements of the median lobe (except the very large) and of the subcervical group of tubules, all fibrous bars, and certain obstructions due to prostatic malignancy. If the prostatic intrusion is mainly intravesical, we prefer suprapubic enucleation by means of the Fuller-Freyer technic. In all other cases, perineal prostatectomy is done. This includes enlargements which are mainly extravesical and encroach on the posterior urethra.

Recently, patients suffering from benign hyperplasia of the prostate, who have passed the period of sexual activity, have been operated upon by the author by means of total prostatectomy in order to minimize the danger of a subsequent development of malignancy (see Total Perineal Prostatectomy, p. 746 (111–56A)). Our results with this procedure have been so good that we perform it by choice unless the patient is still active sexually. In the latter event the operation must not be performed without consultation with the patient, as the seminal vesicles and ampullæ of the vasa deferentia are cut across and ejaculation is therefore impossible.

Preoperative preparation for prostatectomy or resection. *Drainage.* The most important single step in any operation upon the prostate gland, when it is obstructive, is the preoperative preparation of the patient. Irrespective of the type of operation to be done, every patient should be given proper preoperative preparation. This consists primarily of properly managed bladder drainage.

Caution must be exercised when drainage is first instituted. In cases with retention of long standing, uremia may readily result from the sudden reduction of the intravesical pressure by the withdrawal of the entire amount of residual urine. In such cases, one should therefore decompress the patient's bladder gradually before undertaking complete and continuous drainage. It is our custom to reduce the intravesical pressure gradually, first by intermittent catheterization, replacing 50 per cent. of the amount removed with sterile boric acid or other neutral solution, and finally by maintaining continuous outflow by means of a " Y " tube connected with a reservoir, which is first placed so that the tube starts at two feet above the bladder level and then is gradually lowered until the urine is flowing quite freely.

Complete drainage is accomplished either by (1) an indwelling urethral catheter, or (2) suprapubic cystostomy, with suction drainage. The latter is indicated in obstruction of long standing, with considerable renal damage or bladder infection, or if the patient is intolerant of the catheter.

In the Brady Foundation, at the New York Hospital, patients are kept clean, dry, and comfortable, and afforded perfect suprapubic drainage by means of the Kenyon double tube and suction, which is furnished from a general system by means of a wall vacuum. The cystostomy tube is connected to a long piece of rubber tubing which, in turn, is attached to a metal or glass right-angled tube inserted in a two-holed rubber cork in a drainage bottle. The drainage bottle has a capacity of one gallon and fits into a rack which is attached to the frame of the bed. A second long piece of tubing has one end attached to the wall vacuum and the other to a shorter metal or glass tube inserted in the rubber cork. The tube connected to the wall vacuum (exhaust tube) passes

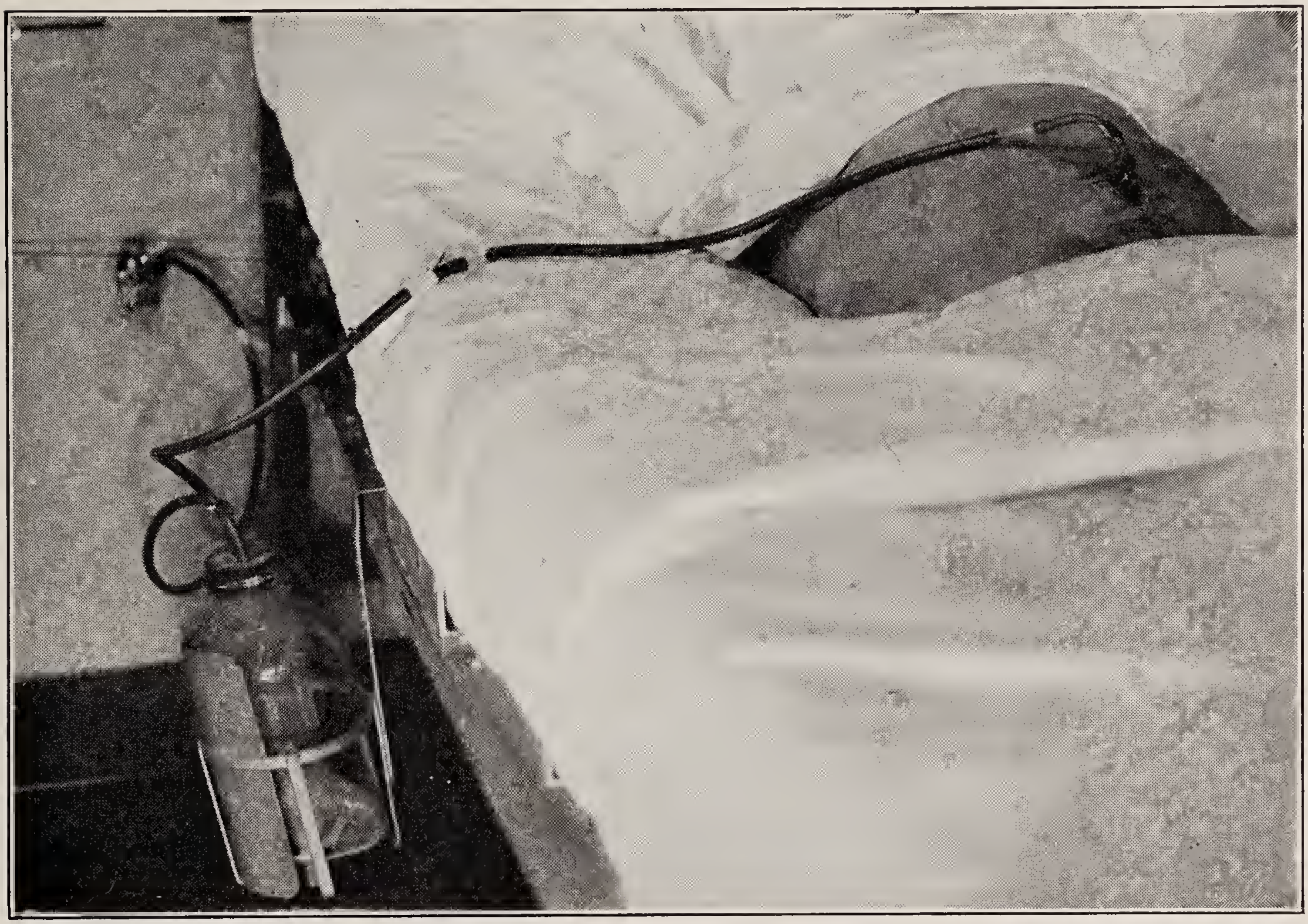

Fig. 40. Suprapubic suction apparatus used at the Brady Foundation, in the New York Hospital. The suction is furnished from a general system to a vacuum bottle attached to the side of the bed. The bottle is connected with the inner tube of a Kenyon double suction tube placed in the patient's bladder. Any fluid arising in the outer tube is suctioned away by the inner tube.

through the cork for a distance of 1 inch; the one connected to the double suction tube (intake tube) passes through the cork for a distance of 5 inches. This difference in length is to prevent bursting bubbles of urine being drawn into the exhaust tube. Suction is obtained by gently pressing the lever of the wall vacuum to get the desired pressure. The double suction tube is irrigated daily, and the inner tube is cleansed and replaced whenever it appears to be blocked. The drainage bottle is changed every 12 hours and is cleansed and sterilized with a germicidal solution. The tubing from the bottle to the patient and the metal connecting-tubes are replaced daily by clean sterile tubing.

Recently we have also used the suprapubic suction pump devised by Dr. Harold E. Stedman at the New York Hospital. This, when used with the double suction tube, efficiently provides continuous suction in suprapubic drainage. It is especially useful in hospitals with only a few urological cases, where the installation of an elaborate vacuum system would be too expensive.

Suprapubic cystostomy, with suction drainage, is accomplished as follows: The bladder is filled with a solution of acriflavine, rivanol dextrose, boric acid, or other neutral solution. A catheter is left

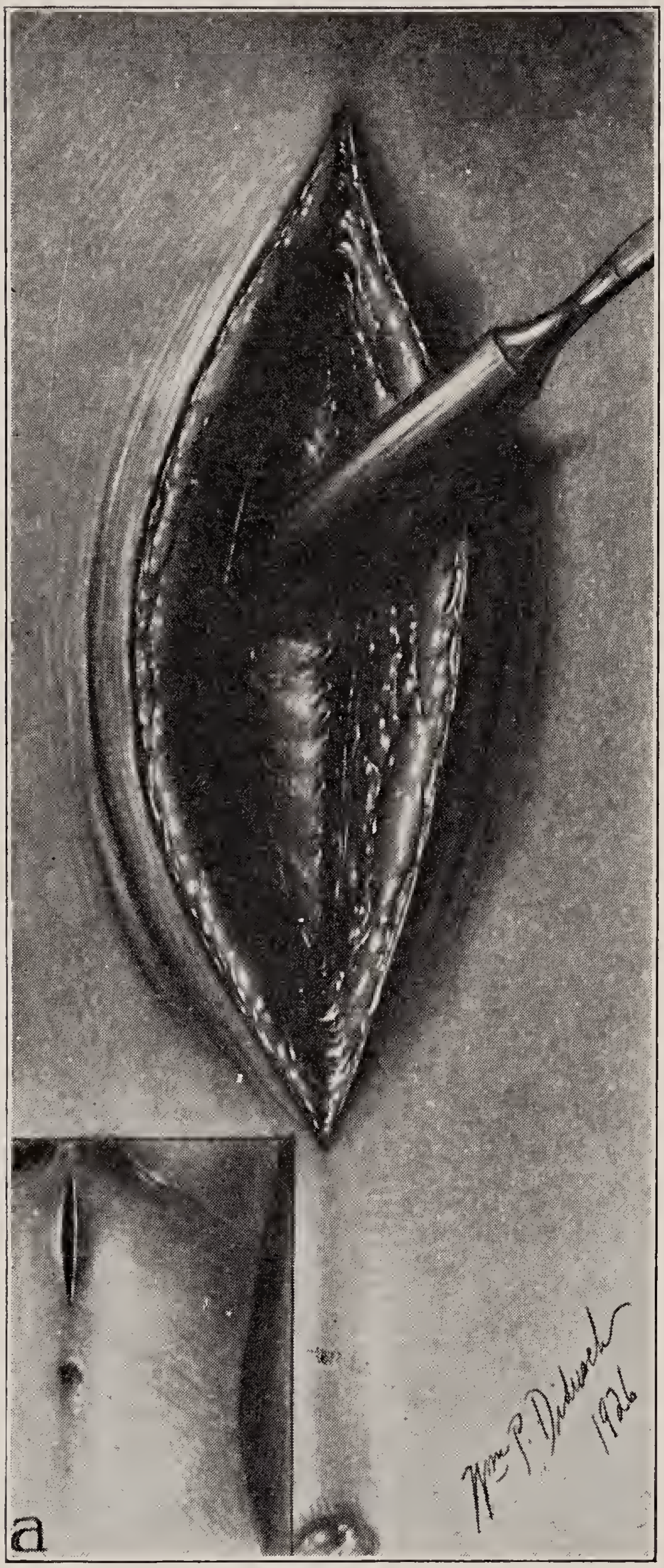

FIG. 41. Suprapubic cystostomy. A 4-inch incision is made above the symphysis pubis, as shown in insert *a*. This is deepened through the subcutaneous tissue and fascia. The recti muscles are separated bluntly. (Courtesy of International Journal of Medicine and Surgery.)

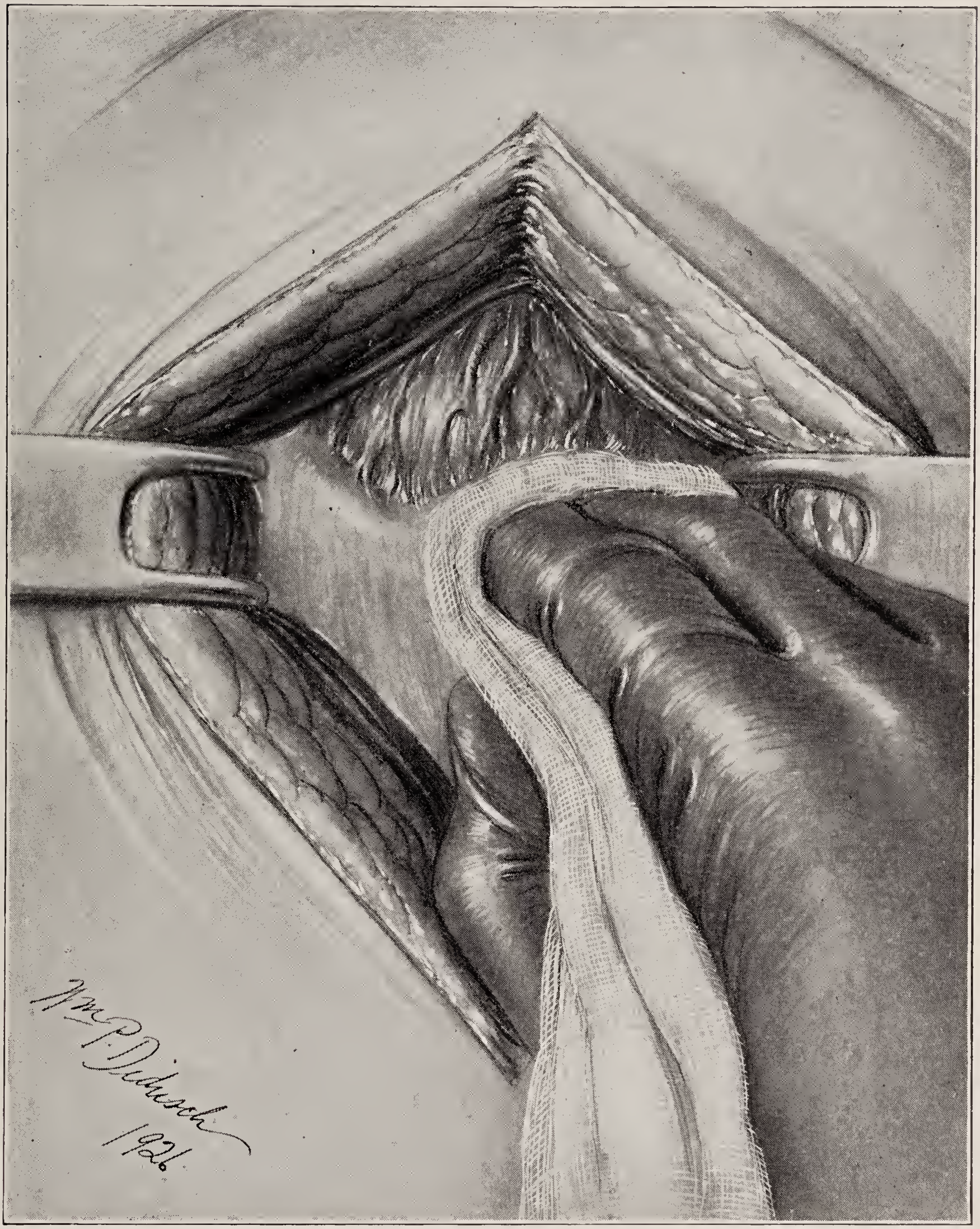

Fig. 42. Suprapubic cystostomy. The prevesical fascia, having been nicked with scissors behind the symphysis pubis, is carefully peeled upward, together with the peritoneum, by the gauze-covered gloved fingers. The muscular coat of the bladder, richly supplied with blood vessels, is thus exposed.

in situ in the distended bladder, its distal end being clamped to prevent the escape of the distending fluid. An incision is made in the midline above the symphysis pubis, and is deepened through the subcutaneous tissue and fascia. The recti muscles are separated bluntly. The prevesical fascia is divided behind the symphysis pubis and, using a gauze-covered gloved finger, the peritoneum is carefully peeled back, exposing the vault of the distended bladder.

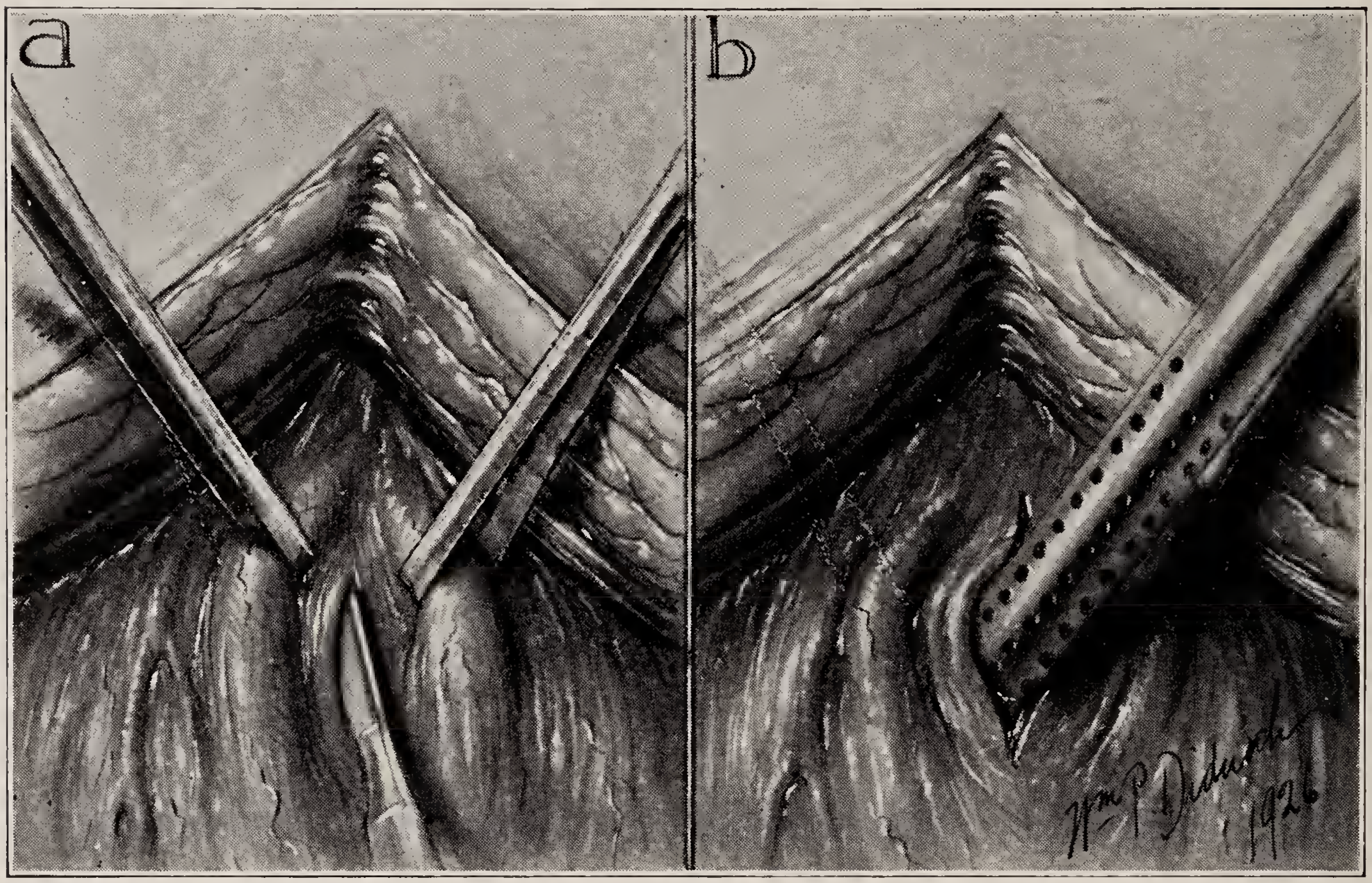

Fig. 43. Suprapubic cystostomy. Insert *a* shows the bladder wall picked up by two Allis clamps and an incision being made between them. A suction tube, *b*, is then introduced into the bladder for the purpose of withdrawing the fluid with which it had been filled previous to the commencement of the operation.

(Another incision utilized by the author in bladder operations is the inverted-V incision, with the apex well above the highest point attained by the dome of the distended bladder. For an ordinary suprapubic cystostomy the apex should come about three-fourths of the distance between the symphysis pubis and the umbilicus. The sheath of the recti is incised on either side and the muscles themselves cut, either partially or entirely as the case may demand. Dissection along the urachus leads directly to the highest point of the bladder fundus.) The exposed bladder wall is easily recognized by the richness of its blood supply and the characteristic muscle fibers. Two Allis clamps are placed upon the bladder wall. The bladder is then incised to the desired length between the clamps and the irrigating fluid sucked out with the usual protected suction device (or the clamp upon the catheter may be released before the incision is made, permitting the distending fluid to flow out until the bladder is entirely empty.) The operator now inserts his gloved finger into the wound to examine the enlarged prostate and explore the interior of the bladder for diverticula, calculi, ulceration, etc. If a stone or other foreign body is present, it is removed at this time. A double suction tube (Kenyon) is then fixed in place with plain catgut at the highest point in the vesical incision and the highest point in the abdominal wound. The bladder wall is repaired by catgut sutures, one of which is tied around the suction tube. A small cigarette drain is inserted along the suture line of the bladder. The abdominal wound is closed in layers, using plain catgut for the recti and fascia, and, for the skin, interrupted silk, dermal, or silkworm-gut sutures, one of which is tied around the double suction tube, fixing its position at the surface. By thus fixing the tube at the highest point in the vesical and skin incisions it is brought through the abdominal wall obliquely.

The length of time of drainage varies with the individual patient. Determination of the correct time to operate on any patient is of the utmost importance. The total output of urine, as well as its contents, must be satisfactory. The function of the kidneys, as determined by repeated phenolsulphonphthalein or urea-clearance tests, must be within normal limits. Blood-chemical estimations will indicate whether toxic substances are being satisfac-

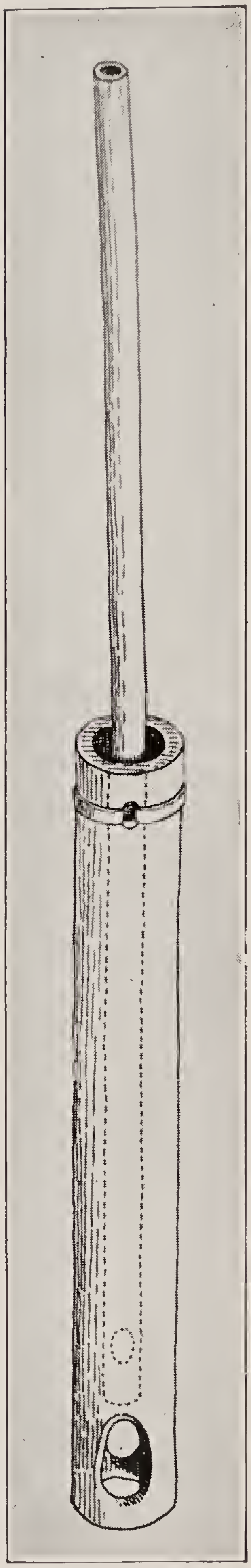

FIG. 44. Suprapubic cystostomy. Double suction tube. The large outer tube is fixed in the bladder at the highest point of the vesical incision and of the abdominal wound. The small inner tube is connected with a vacuum bottle attached to the bed (see Fig. 40). Any fluid arising in the outer tube is sucked away by the inner tube, which has a lateral window so that, should the end by any chance slip down to the bladder wall, that structure would not be drawn up into the tube and ulceration caused.

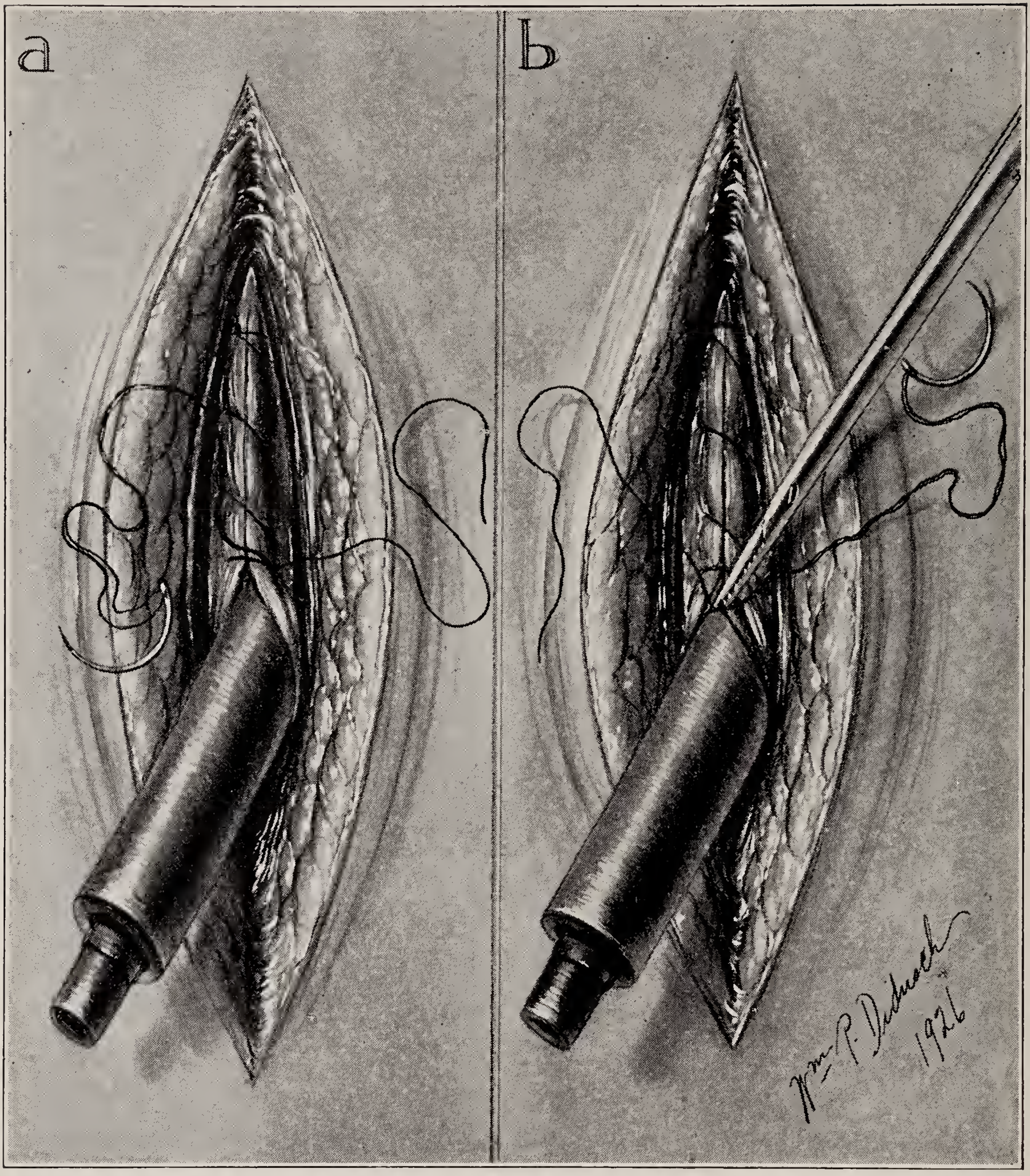

FIG. 45. Suprapubic cystostomy. Insert *a* shows the double suction tube sutured to the highest point of the bladder incision. Insert *b* shows the catgut tied around the tube, firmly fixing it in position; the ends of the suture are then fixed at the highest point of the fascia wound. The bladder wall and body wall are snugly drawn together to avoid pocketing and to insure a high, oblique fistula. (Courtesy of International Journal of Medicine and Surgery.)

torily drained from the entire body mechanism. When all of these tests are satisfactory, the most important test of all is applied, namely

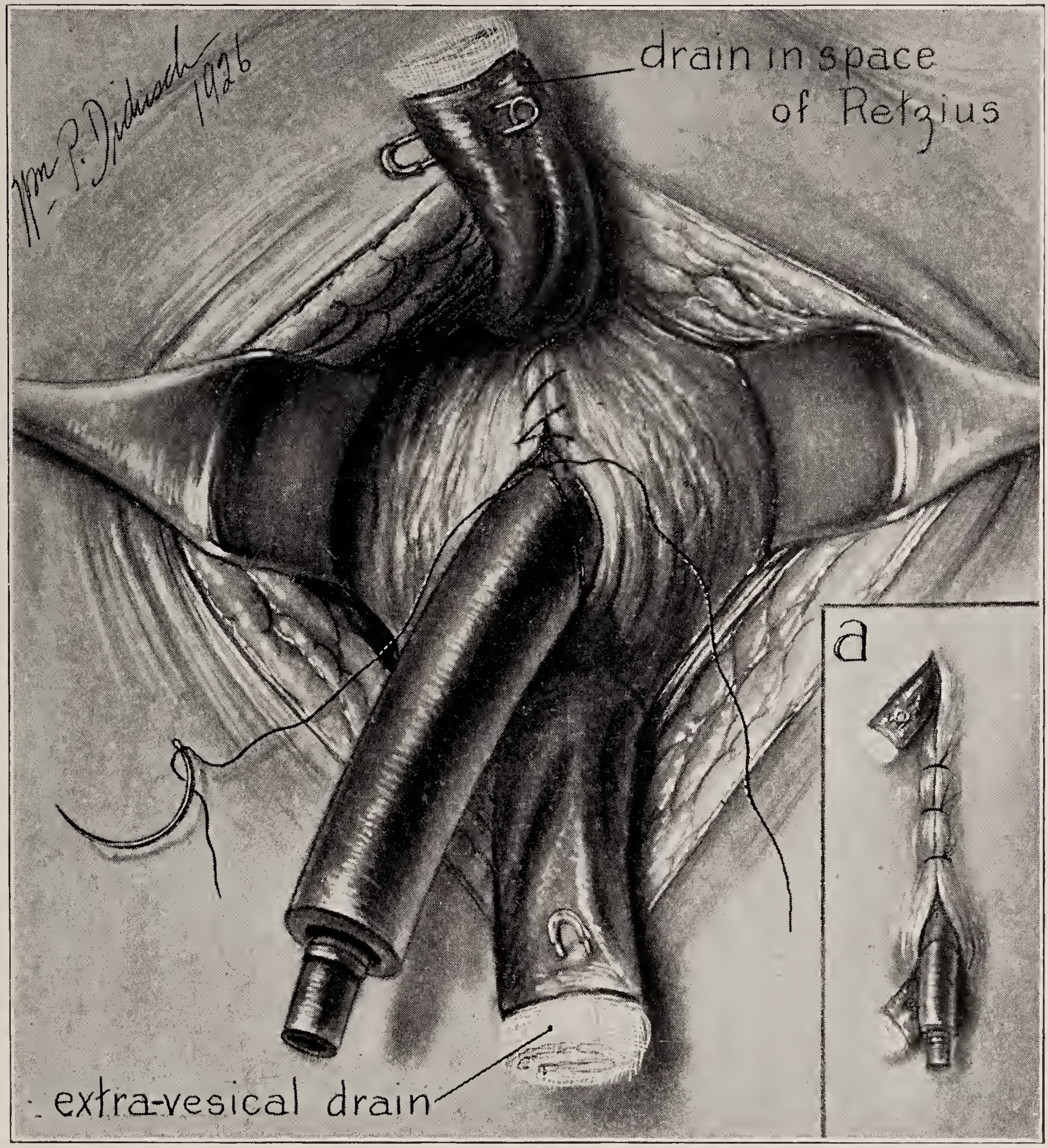

FIG. 46. Suprapubic cystostomy. A small drain is placed extravesically down to the end of the incision and another in the space of Retzius. Insert *a* shows final closure.

the general appearance and spirit of the patient. It is the practice of the author to wait until the patient can walk the length of the hall several times without tiring and until he looks and feels fine. When he begins to get anxious to have the second stage of the operation over with, the time is usually ripe for the surgeon to operate.

None of the preliminary measures considered essential for one about to undergo perineal or suprapubic prostatectomy should be omitted when it has been decided to do a transurethral resection of the obstructing prostate. Measurement of the residual urine, blood-

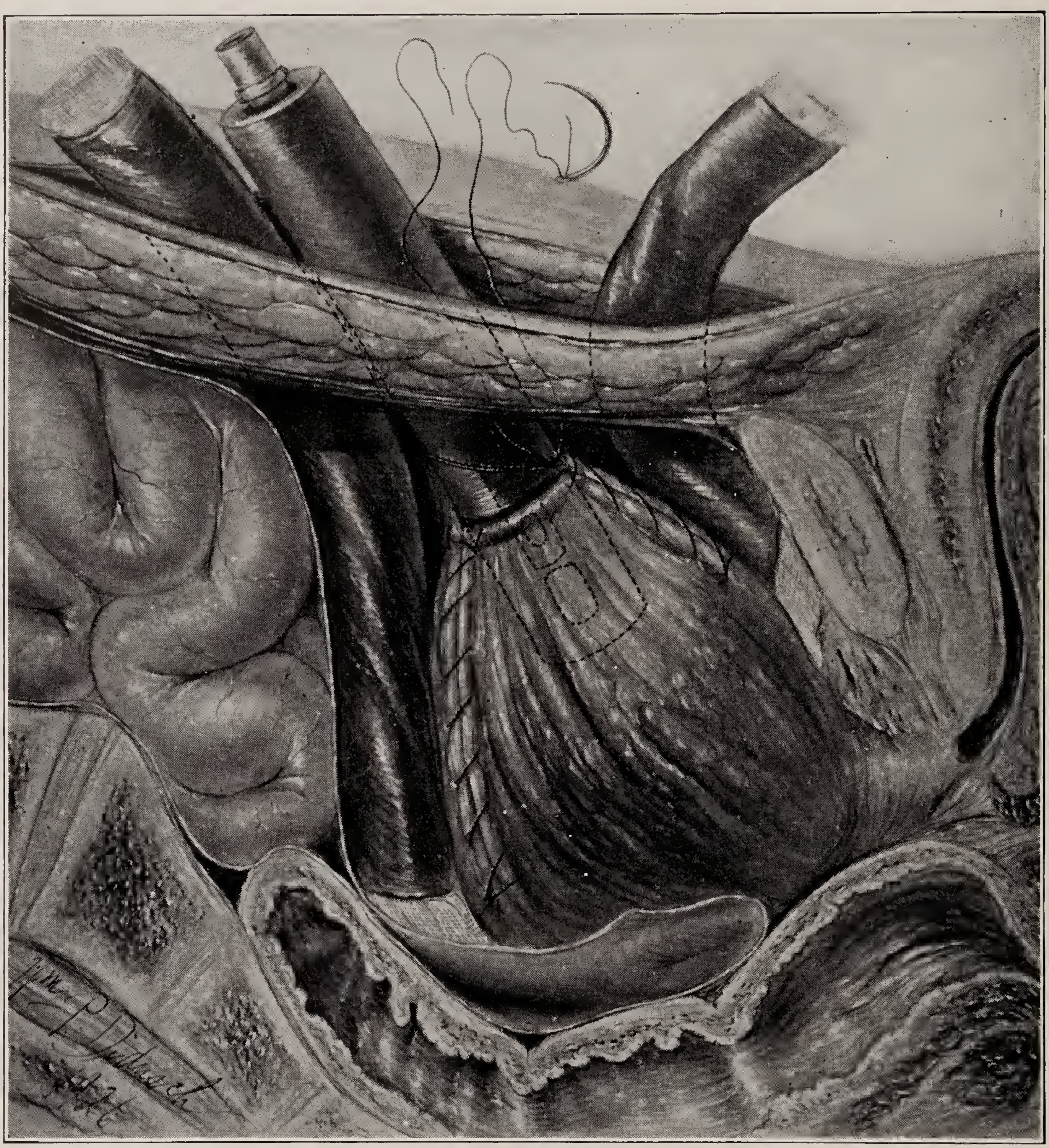

FIG. 47. Suprapubic cystostomy. Sagittal section showing double suction tube and drains placed. The tube is about to be drawn upward by means of a suture placed in the fascia of the rectus muscle.

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chemical and phenolsulphonphthalein tests, urinalysis, and the institution of catheter drainage, if necessary, are just as important as in open operation. Suprapubic cystostomy is seldom necessary, however, for if conditions are such as to demand gradual decompression or suprapubic cystostomy — residual urine being so large in amount and intrusion of the lateral lobes sufficient to make such drainage imperative — the case, in the author's judgment, is distinctly unsuited for transurethral resection unless there is malignant degeneration.

Certain routine procedures are done preoperatively, in the author's

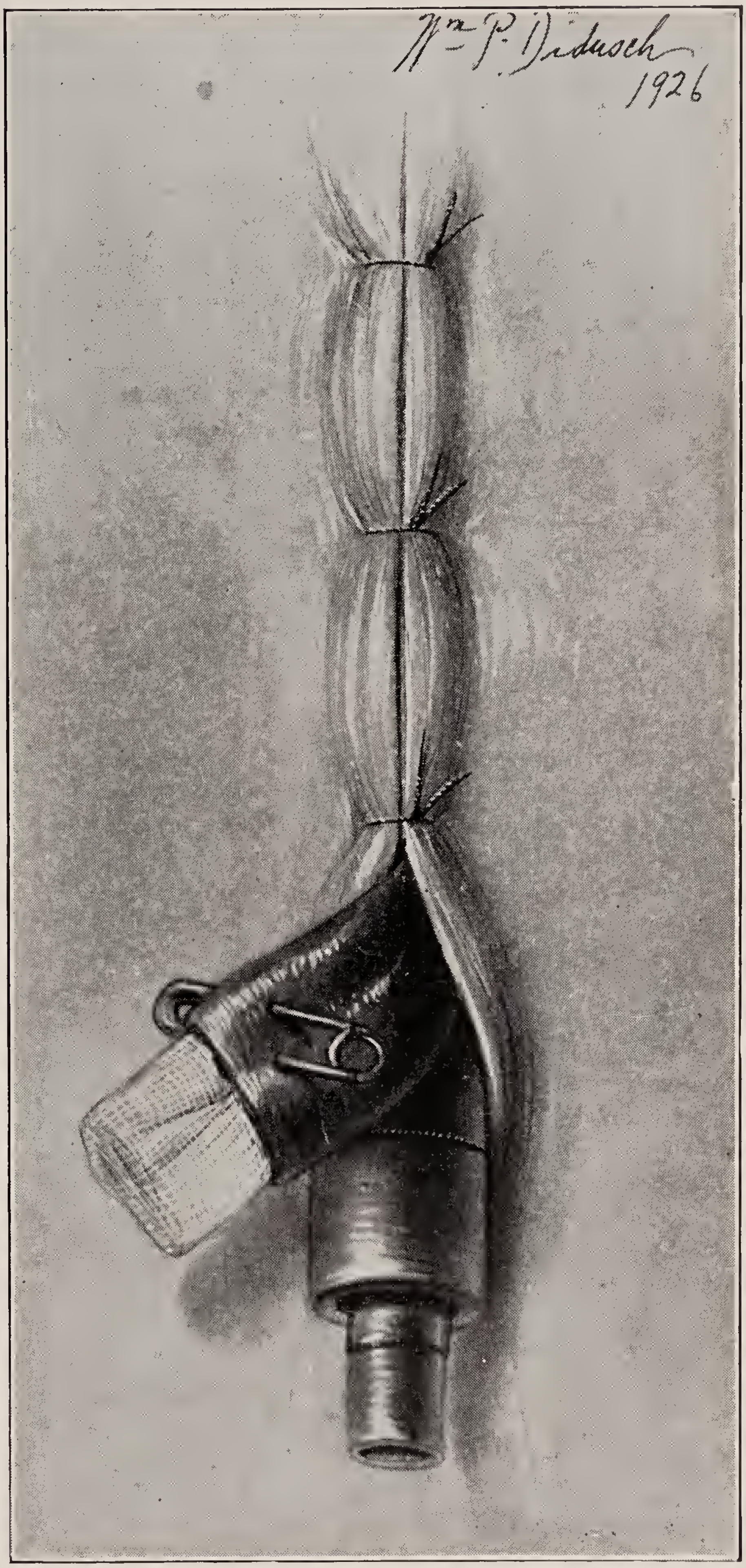

Fig. 48. Suprapubic cystostomy. This picture shows the completed operation, the suction tube being fixed at the top of the skin incision. Upon removal of the tube, and especially when the patient assumes the erect posture, the direct oblique fistula through the body wall will be closed by the pressure of the abdominal contents. It has been found that high, oblique fistulas such as this heal more promptly than those which are placed lower and less obliquely. In fact, it is easier for urine to flow out through such a fistula than through the natural channel, as the latter is protected by sphincters and, in the erect posture, the vesical orifice is about on the same level as a fistula emanating at a point just above the symphysis.

service, in every case of prostatic hyperplasia. A plain x-ray is always taken to determine the size, conformation, and location of the kidneys, and to ascertain if there are any calculi in the urinary tract. Routine cysto-urethrograms are also made. Another routine measure is the making of an electrocardiogram. The information gained from this, whether favorable or unfavorable, is of great importance to the surgeon. Blood-pressure estimations over the period of preoperative preparation are most helpful. A subnormal blood pressure, or a too sudden drop from an abnormally high blood pressure, is viewed with alarm. A fall in blood pressure is usually noted during the period of preliminary drainage, and is probably due to the relief of the general bodily mechanism from the retention in the blood of toxic elements resulting from obstruction and back pressure.

Medication: Fluids: Diet. Fluids are usually forced during the preoperative course, and the patient is given a general diet unless some special contraindication exists. Spices and alcohol are interdicted. Purgation is given at least 24 hours before operation, and fluids are taken up to, during, and immediately after operation (when regional anesthesia is used), thus preventing dehydration. A low carbon-dioxide coefficient of the blood means hyperacidity, which is relieved by the administration of sodium bicarbonate powder by mouth, or by rectum in a 5 per cent. solution. When indicated, urinary antiseptics should be administered until 48 or 24 hours before operation. The sulfonamides and methenamine are the antiseptics most frequently used. The latter is very satisfactory for this purpose. Five grains (0.3 gram), dissolved in a glass of water, is given every two or three hours. An acidifying agent, such as acid sodium phosphate (0.3 gram), is administered with the methenamine.

Final Preoperative Examination. On the day of operation, the patient is given a final thorough physical examination which includes the general appearance, head (the eyes and tongue particularly), chest, abdomen, and extremities. A careful review is made of his temperature and pulse-rate charts and blood-pressure comparisons. The advantages of such a course have been repeatedly exhibited to us in our urological work. Not infrequently a patient, apparently entirely ready for surgical intervention, has been discovered at the last moment to have some complicating condition that makes postponement of the operation advisable.

Preliminary bilateral vasectomy. It is our practice to perform

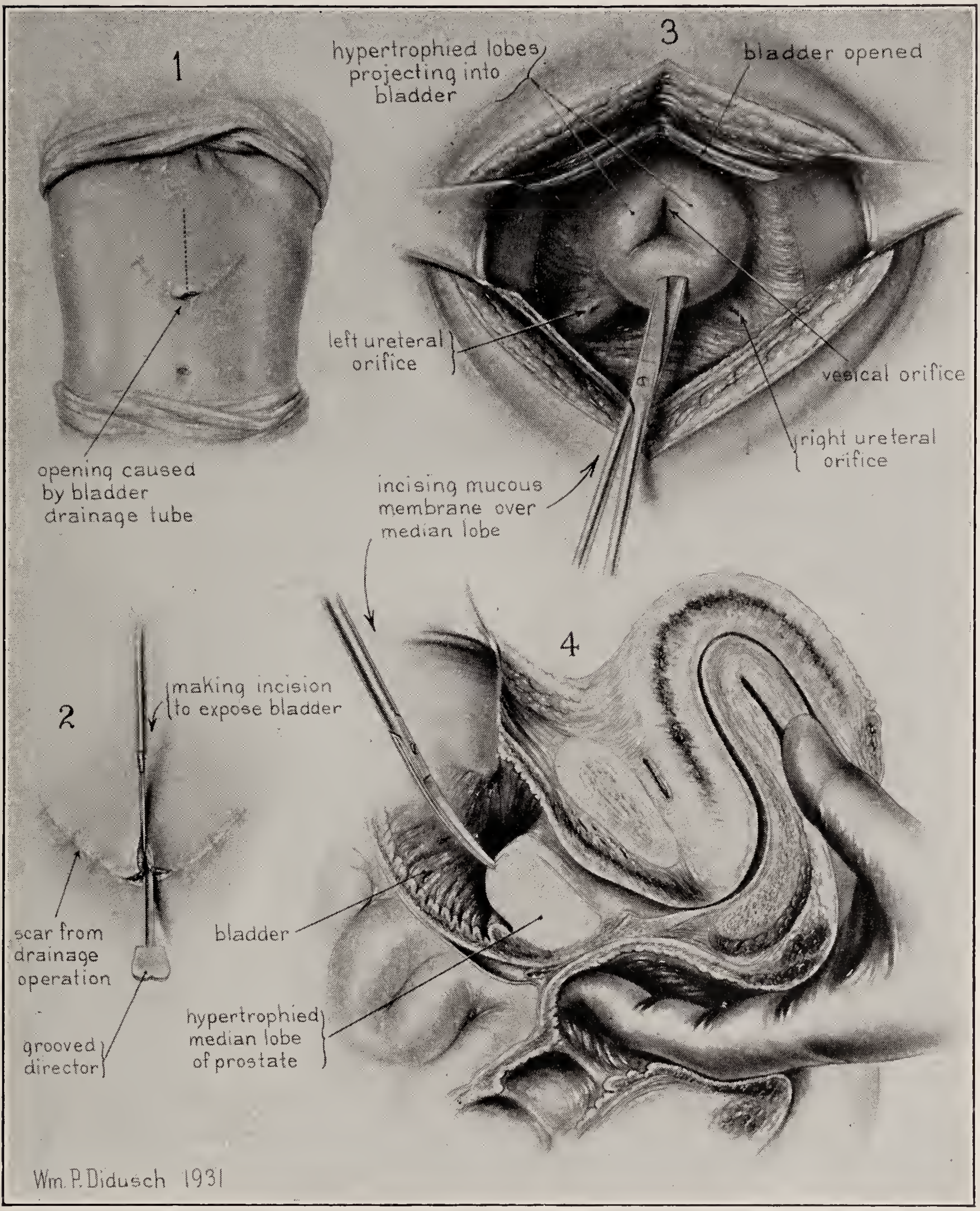
1
opening caused by bladder drainage tube
2
making incision to expose bladder
scar from drainage operation
grooved director
3
hypertrophied lobes projecting into bladder
bladder opened
left ureteral orifice
vesical orifice
right ureteral orifice
incising mucous membrane over median lobe
4
bladder
hypertrophied median lobe of prostate
Wm. P. Didusch 1931

FIG. 49. Suprapubic prostatectomy. (1, 2) The high suprapubic fistula from the preceding cystostomy is incised downward through virgin tissue (dotted line) to expose the bladder. (This drawing shows the scar of the V incision sometimes preferred by the author for operations upon the bladder.) (3) The bladder has been opened, exposing the intruding prostate gland. With scissors, a nick is made in the most prominent presenting portion. (4) A finger in the rectum pushes the prostate well up into the bladder, making enucleation easier. (Courtesy of Journal of American Medical Association.)

bilateral vasectomy before every suprapubic prostatectomy in order to avoid postoperative epididymitis, as the orifices of the ejaculatory ducts are apt to be injured during enucleation and laid

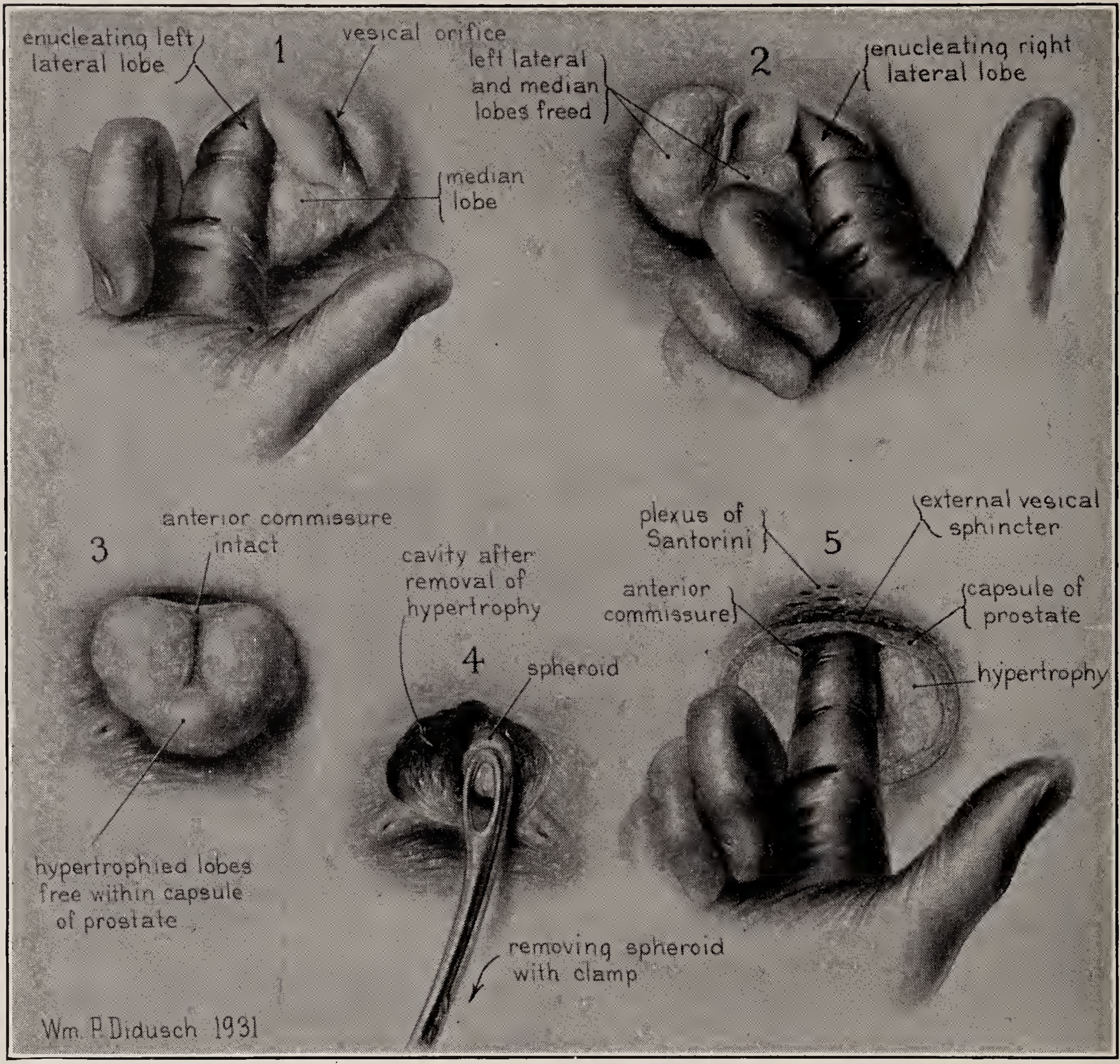
enucleating left lateral lobe
1
vesical orifice
left lateral and median lobes freed
2
enucleating right lateral lobe
median lobe
anterior commissure intact
3
cavity after removal of hypertrophy
4
spheroid
plexus of Santorini
5
external vesical sphincter
anterior commissure
capsule of prostate
hypertrophy
hypertrophied lobes free within capsule of prostate
removing spheroid with clamp
Wm. P. Didusch 1931

Fig. 50. Suprapubic prostatectomy. (1 to 5) Enucleation of the prostate is accomplished by the operator inserting his index finger through the opening in the capsule and sweeping it in all directions inside the capsule until the enlarged gland has been entirely detached from it. Great care must be taken to avoid splitting the top of the vesical orifice and injuring the rich venous plexus of Santorini. (Courtesy of Journal of American Medical Association.)

open to infection. In conservative perineal prostatectomy by the author's technic the verumontanum is respected and the orifices of the ejaculatory ducts do not suffer injury. Therefore, preliminary vasectomy is unnecessary. Some operators, however, do this pro-

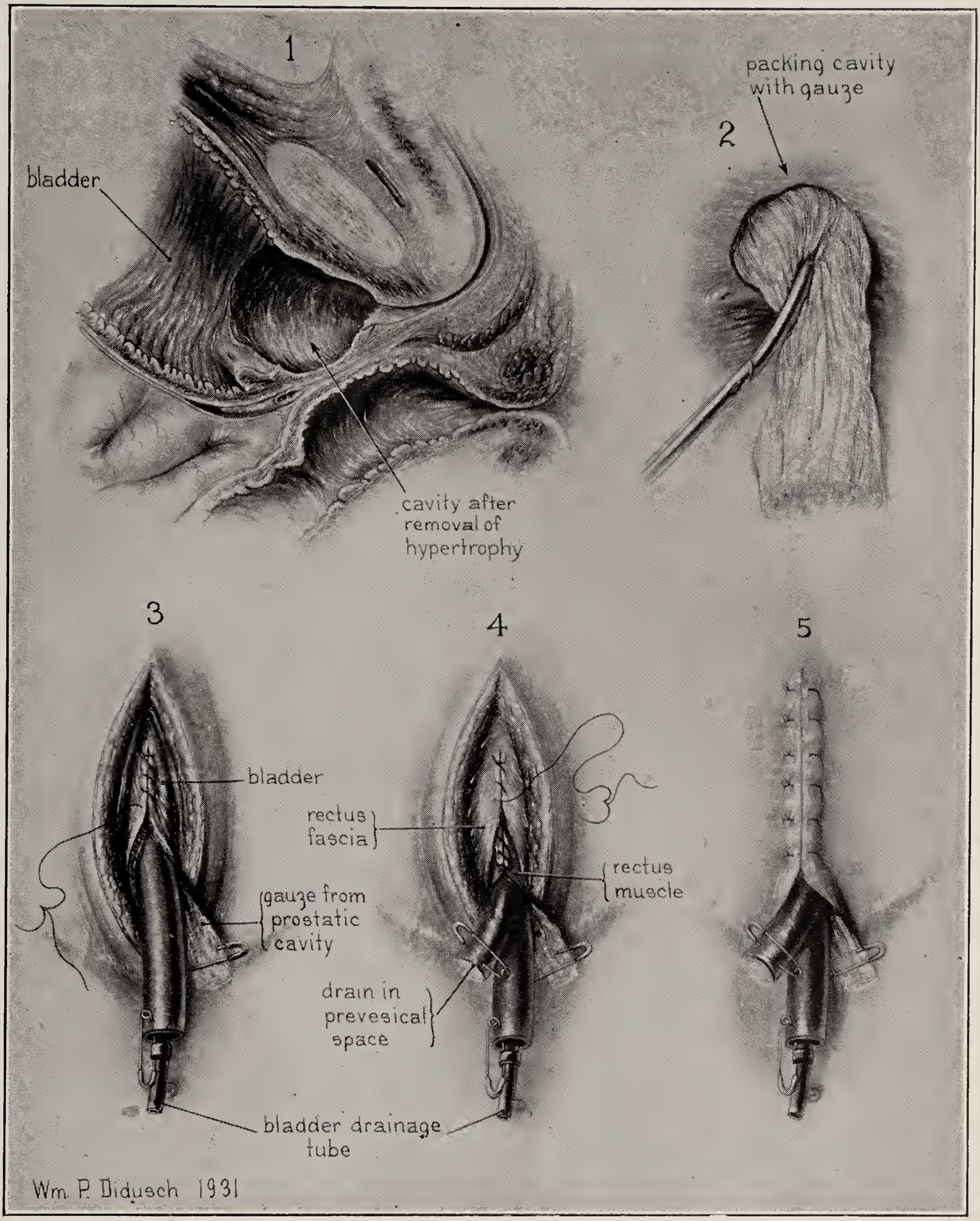
1
bladder
cavity after removal of hypertrophy
2
packing cavity with gauze
3
bladder
gauze from prostatic cavity
4
rectus fascia
rectus muscle
drain in prevesical space
5
bladder drainage tube
Wm. P. Didusch 1931

FIG. 51. Suprapubic prostatectomy. (1) Sagittal view showing the appearance of the cavity after enucleation of the prostate. (2) Packing the cavity with petrolatum gauze. (3) Kenyon double suction tube fixed in position at the highest point of the bladder wound. (4) Cigarette drain inserted at the top of the incision in the body wall. (5) Skin closure, with tube, drain, and gauze emerging at the top. (Courtesy of Journal of American Medical Association.)

cedure routinely. Before transurethral resection, we usually perform vasectomy in older men, but not in those who are still in the period of sexual activity.

Technic of suprapubic prostatectomy. The technic preferred by us is the so-called Fuller-Freyer operation, originated four decades ago.

The properly prepared and anesthetized patient is placed on the operating table in such a manner that he may readily be put in the Trendelenburg position. The high suprapubic fistula from the preliminary cystostomy is incised downward toward the symphysis and the bladder wound is incised toward the vesical orifice. (If there has been no preliminary cystostomy, the bladder is exposed through the incision preferred by the operator — vertical midline, inverted-V, transverse, etc. — and the bladder wall grasped by two Allis clamps and incised to the desired length between them, as previously described under suprapubic cystostomy.)

The capsule of the most projecting portion of the prostate is opened by means of scissors. The operator's finger is inserted through the opening, the line of cleavage established, and the enucleation accomplished by sweeping the index finger in all directions inside the capsule until the enlarged gland has been entirely detached from it. Great care must be taken to avoid splitting the top of the vesical orifice, with the inevitable injury to Santorini's plexus which this accident involves. A finger in the rectum, while the prostate is being enucleated, steadies the gland and pushes it forward toward the suprapubic opening, making enucleation far easier.

When the finger reaches the verumontanum, some difficulty in enucleation is invariably encountered. As this is the most distant point that the finger endeavors to reach, a short finger may not be able to attain it. Consequently the gland may have to be grasped and torn away, usually bringing with it some or all of the verumontanum's mucosa. The ejaculatory ducts are thus denuded of their natural protection against infection, and epididymitis is likely to occur if bilateral vasectomy has not previously been done.

When the prostate has been enucleated, the patient is put in the Trendelenburg position. All remaining tags of tissue are cleared away, leaving the prostatic capsule smooth, with no débris to undergo necrosis and encourage infection of the cavity left by removal of the gland. Using sponge forceps, a sponge of gauze is dipped in hot saline solution and inserted into the prostatic cavity

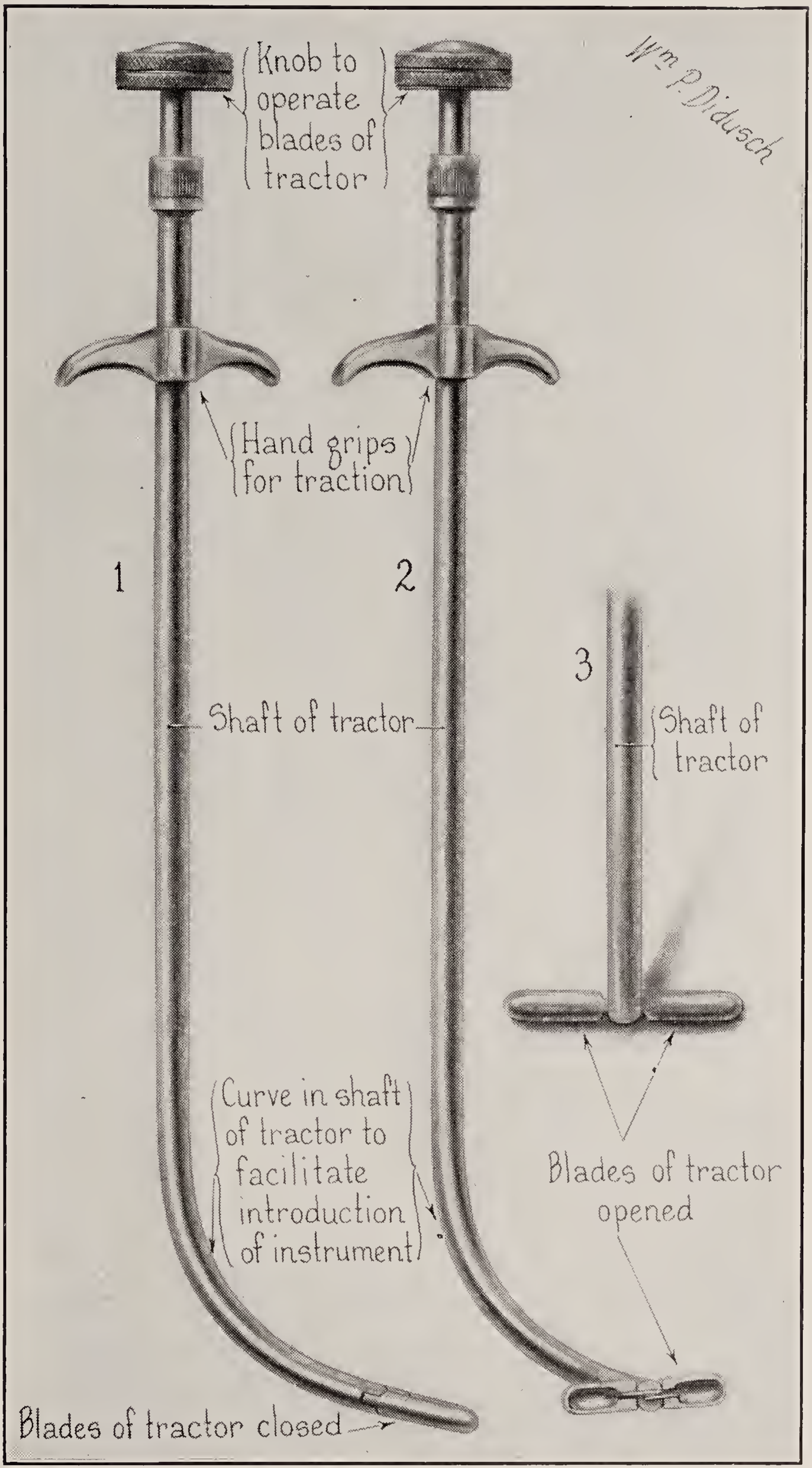

FIG. 52. Lowsley prostatic tractor, with curved shaft and blades that are opened and closed by means of a knob. (From "Clinical Urology" by Lowsley and Kirwin, published by The Williams & Wilkins Company.)

to control the immediate hemorrhage. Pressure can be put on by the assistant. The cavity is then packed with vaseline gauze. As this gauze is a semifluid substance, the prostatic capsule will expel a portion of it should the packing be too tight, thus automatically relieving any undue pressure. A Kenyon double suction tube is inserted, and the wound is closed in layers.

The packing is removed 36 to 48 hours after operation, 30 to 60 cc. of 2 per cent. procaine borate solution, or other anesthetic solution, being instilled into the bladder before the dressing is done to ease the pain of removal.

One of the many prostatectomy bags for the arrest of hemorrhage (Hagner, Davis, Foley, Pilcher, Brake, etc.) is frequently used in place of the gauze. After enucleation of the gland, the glove is changed for a sterile one. A sound is passed through the urethra and the catheter end of the bag is inserted on the sound and drawn through the urethra. The bag is then inflated with water and inserted into the prostatic cavity, and placed under tension for two or three hours. The tension is then released, leaving the water-filled bag in place. After 24 hours the bag is deflated but still left in position. If no hemorrhage occurs within 48 hours, the bag is removed and a catheter inserted.

Postoperatively we use a suprapubic suction cup (the design of which was originally suggested to us by Mr. Leo Savolly, an orderly at the New York Hospital) to take care of any suprapubic leakage and bridge the period between the removal of the drainage tube and the healing of the suprapubic sinus. Some operators use the suction cup without a catheter in the urethra. The cup consists of a flat, hollowed-out rubber sponge. Inside its rim is a turn of small rubber tubing with several holes. One end of this tubing is sealed, while the other extends out the side of the cup and is attached to the drainage bottle. There are two vents in the collecting chamber of the cup. No actual suction is made on the sinus, the urine merely being drawn off as it wells up into the cup. After the double suction tube has been removed, the suction cup is placed on the abdomen directly over the sinus so that the fistula is in the center of the hollowed-out portion of the cup. It is held in place by adhesive straps. Over the cup is placed a gauze pad held in place by Montgomery straps. The cup is connected to the suction apparatus in the same manner as the double suction tube, or it may be used in conjunction with the Stedman induction motor suction pump.

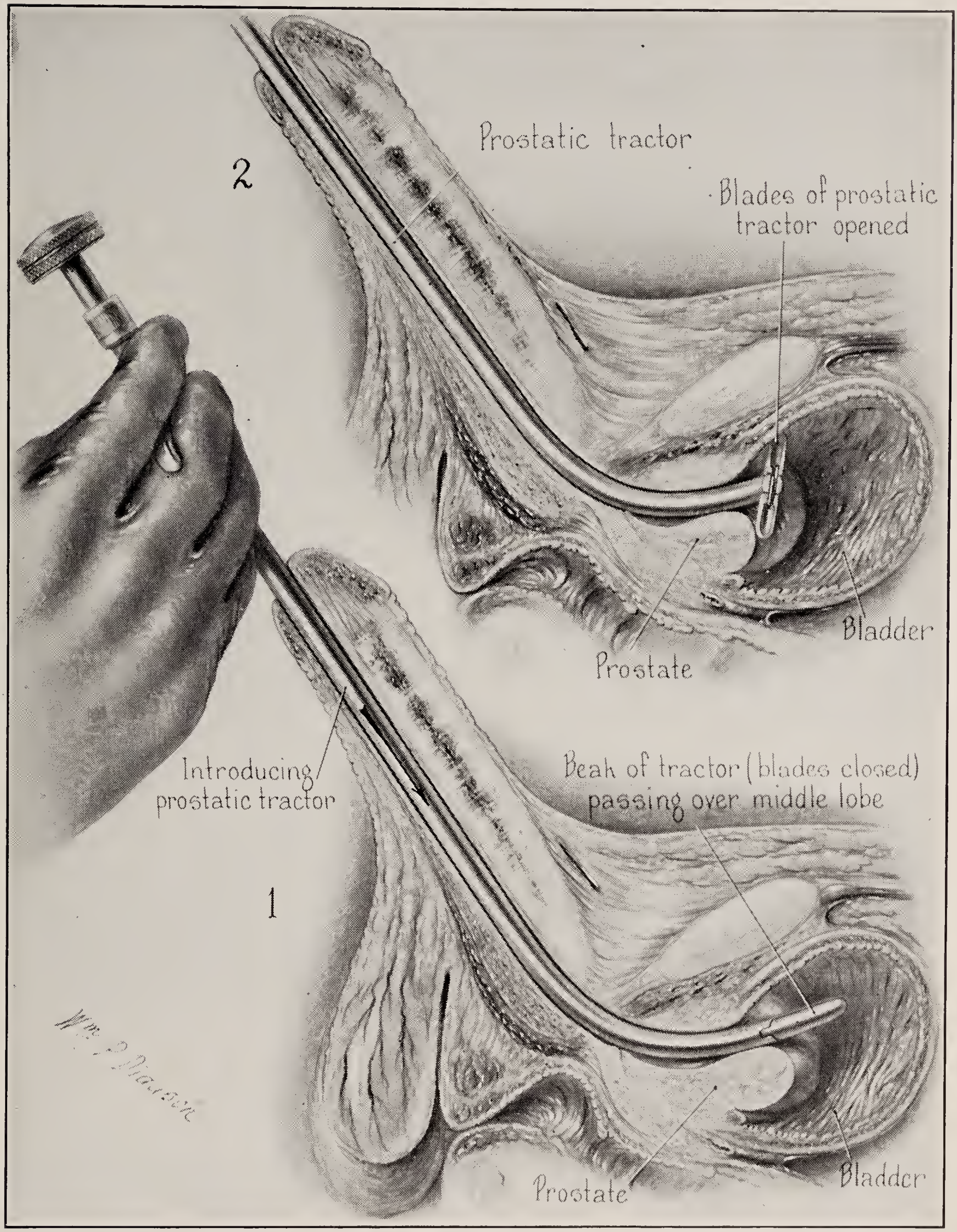
2
Prostatic tractor
Blades of prostatic tractor opened
Bladder
Prostate
Introducing prostatic tractor
Beak of tractor (blades closed) passing over middle lobe
1
Prostate
Bladder
Wm. P. Didusch

FIG. 53. Lowsley prostatic tractor. (1) Introducing the tractor. Without the curved shaft it would be difficult, if not impossible, to pass the instrument into the bladder. (2) The blades are opened and traction about to be maintained. (From "Clinical Urology" by Lowsley and Kirwin, published by The Williams & Wilkins Company.)

Technic of perineal prostatectomy. Perineal prostatectomy is frequently preceded by a suprapubic cystostomy for drainage, but in many cases preliminary drainage is secured by means of an indwelling urethral catheter so that there is no suprapubic wound.

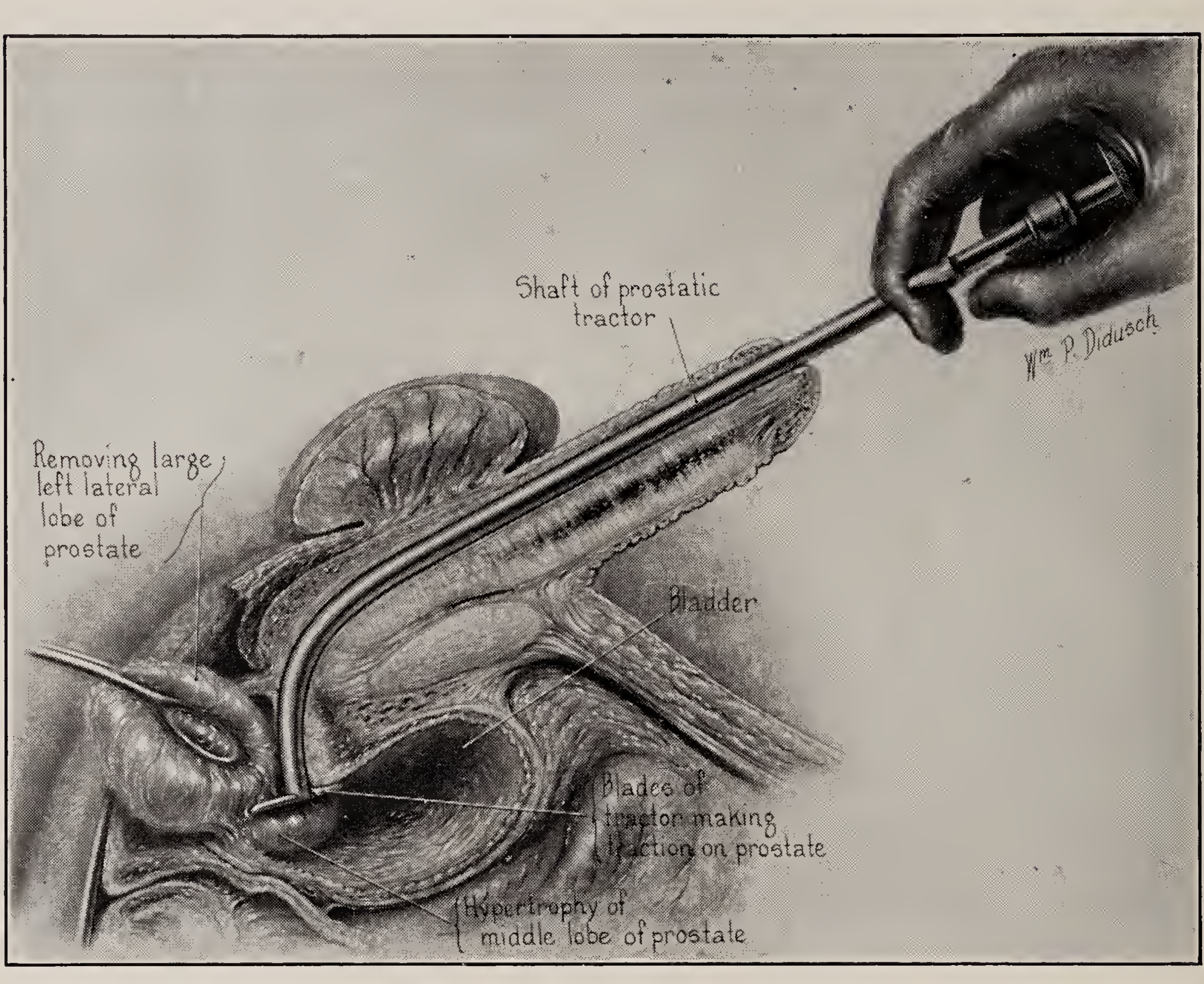
Shaft of prostatic tractor
Wm P. Didusch
Removing large left lateral lobe of prostate
Bladder
Blades of tractor making traction on prostate
Hypertrophy of middle lobe of prostate

FIG. 54. Lowsley prostatic tractor. Sagittal view showing removal of large left lateral lobe of the prostate, with the gland being drawn downward and held thus by the tractor. (From "Clinical Urology" by Lowsley and Kirwin, published by The Williams & Wilkins Company.)

The technic preferred by the author is the following modification of Young's conservative perineal prostatectomy.

The patient is placed on the operating table in an exaggerated lithotomy position. The Lowsley prostatic tractor is passed into the bladder through the urethra and its blades opened. A crescentic incision is made through the skin in the perineum, about one inch above the anus, and deepened through the subcutaneous tissue until the central tendon of the perineal muscles is exposed. The space on each side of the central structures is opened by sharp and blunt dissection. The central tendon is then incised behind the point where the lateral perineal muscles join it, which allows the central structures to be pulled upward with the bulb and the lateral perineal muscles. A Kocher clamp is fixed to the posterior part of the central tendon and held in the left hand for the purpose of traction. The gloved index finger of the left hand is inserted into the rectum as a safeguard and the hand is covered with a towel. The dissection is carried deeper and the recto-urethralis muscle (the important reflection of the levator ani which attaches the rectum to the urethra at the apex of the prostate) is incised.

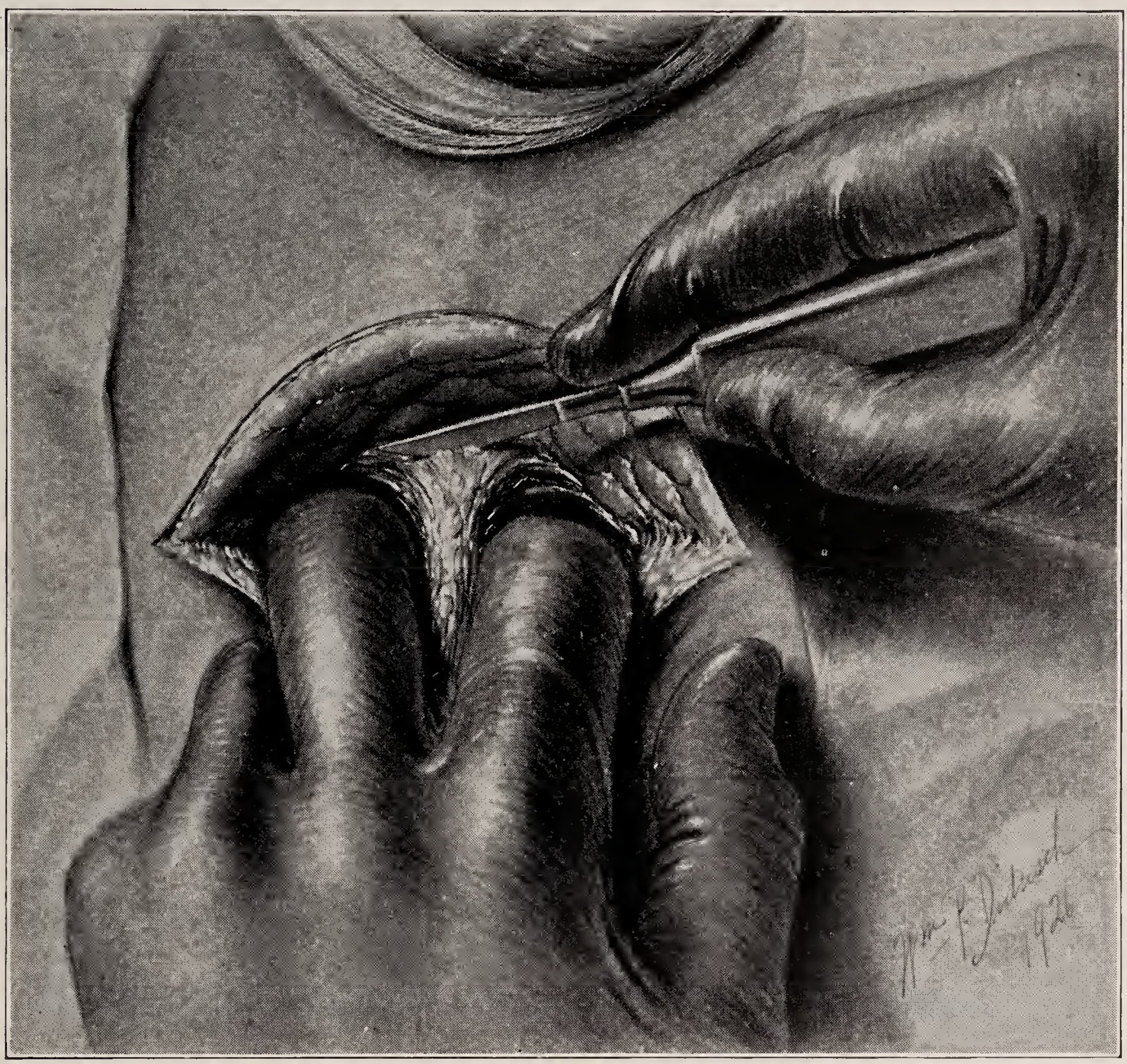

Fig. 55. Perineal prostatectomy. A crescentic incision has been made through the skin in the perineum, about one inch above the anus, and the ischiorectal fossa on each side of the central structures has been opened by sharp and blunt dissection. With the fingers in the ischiorectal fossæ, the central tendon is incised behind the point of insertion of the lateral perineal muscles.

The levator ani muscle is then dissected from the posterior surface of the prostate, which is recognized by the glistening fascia of Denonvilliers covering the posterior surface. Thus, not only has the posterior urethra not been opened — an extremely important point in the prevention of incontinence of urine — but often it is not even seen. The left index finger is removed from the rectum and the glove changed. A posterior tractor is then placed in position.

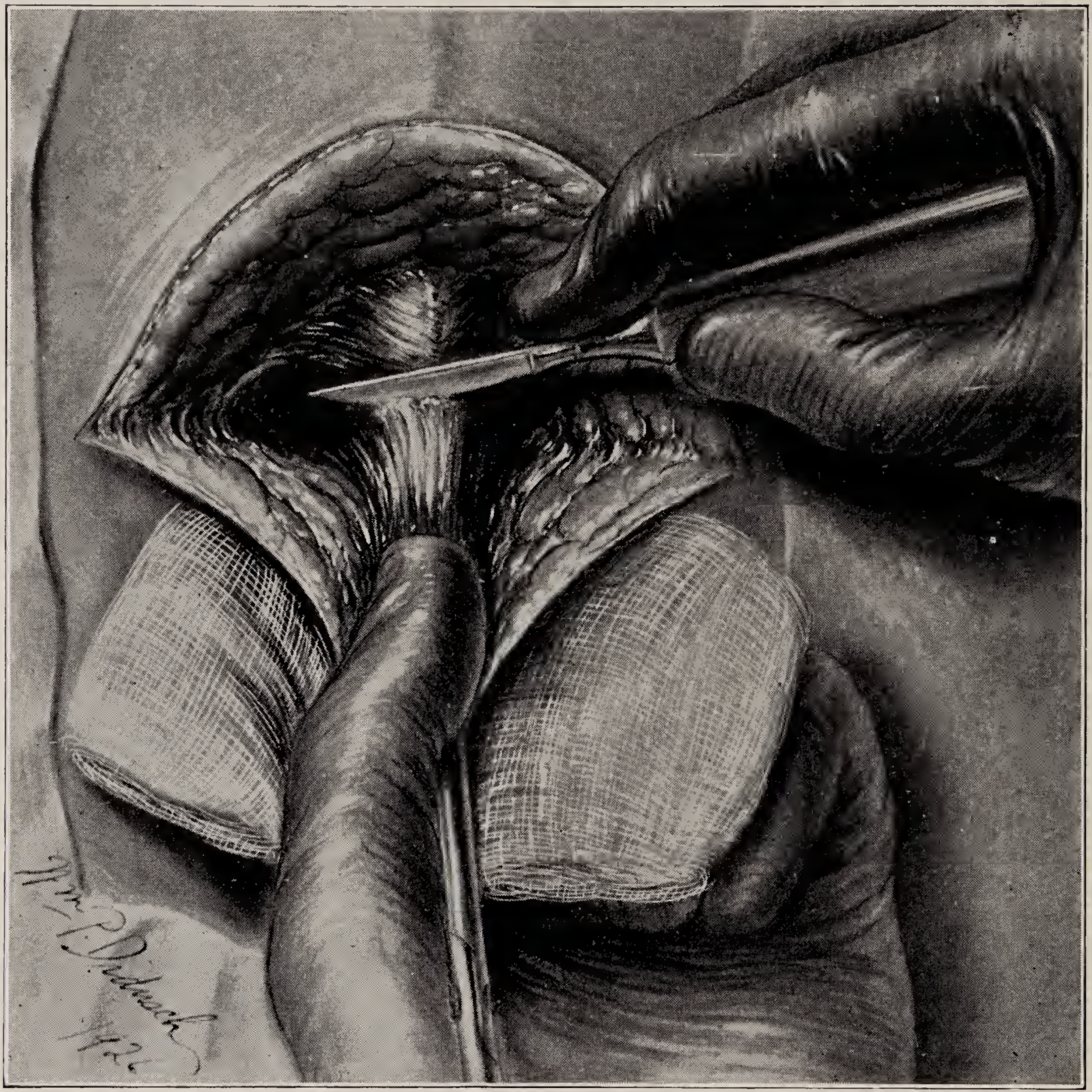

Fig. 56. Perineal prostatectomy. The gloved index finger of the operator's left hand is inserted into the rectum, protecting that structure, and the recto-urethralis muscle is incised. (From "Text-Book of Urology" by Lowsley and Kirwin, published by Lea & Febiger.)

An inverted-V slit is made in the posterior surface of the prostate, its apex being at the exact apex of the gland, and carried down to the posterior urethra. When this tongue-shaped flap is drawn back, the verumontanum is seen. A transverse incision is

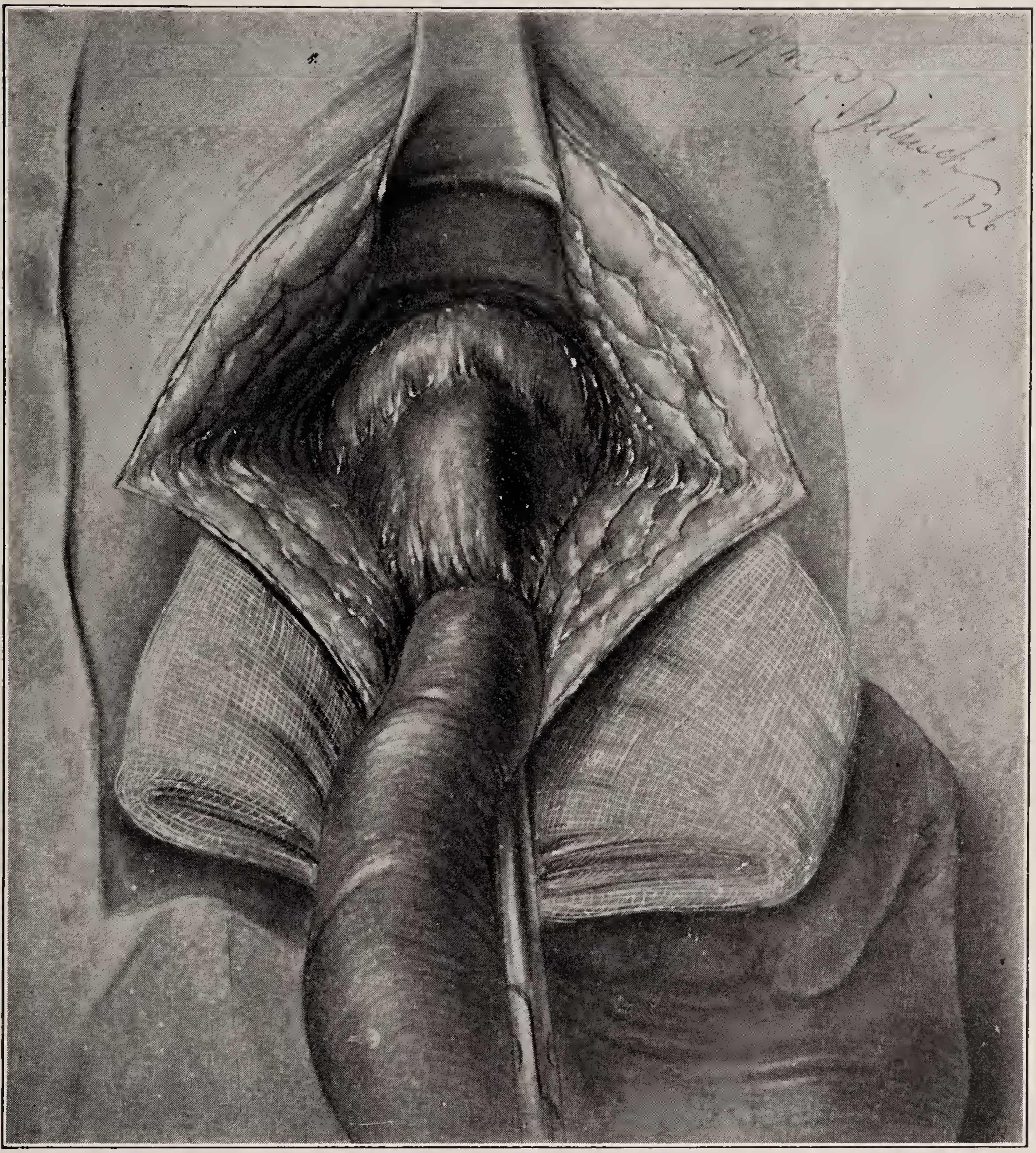

FIG. 57. Perineal prostatectomy. The bulb is retracted upward. The finger in the rectum exposes the apex of the prostate. The groove between the rectum and the prostate is seen. With the gloved finger still in the rectum, the levator ani muscle is separated from the posterior surface of the prostate, which is easily distinguished by the glistening fascia of Denonvilliers covering it.

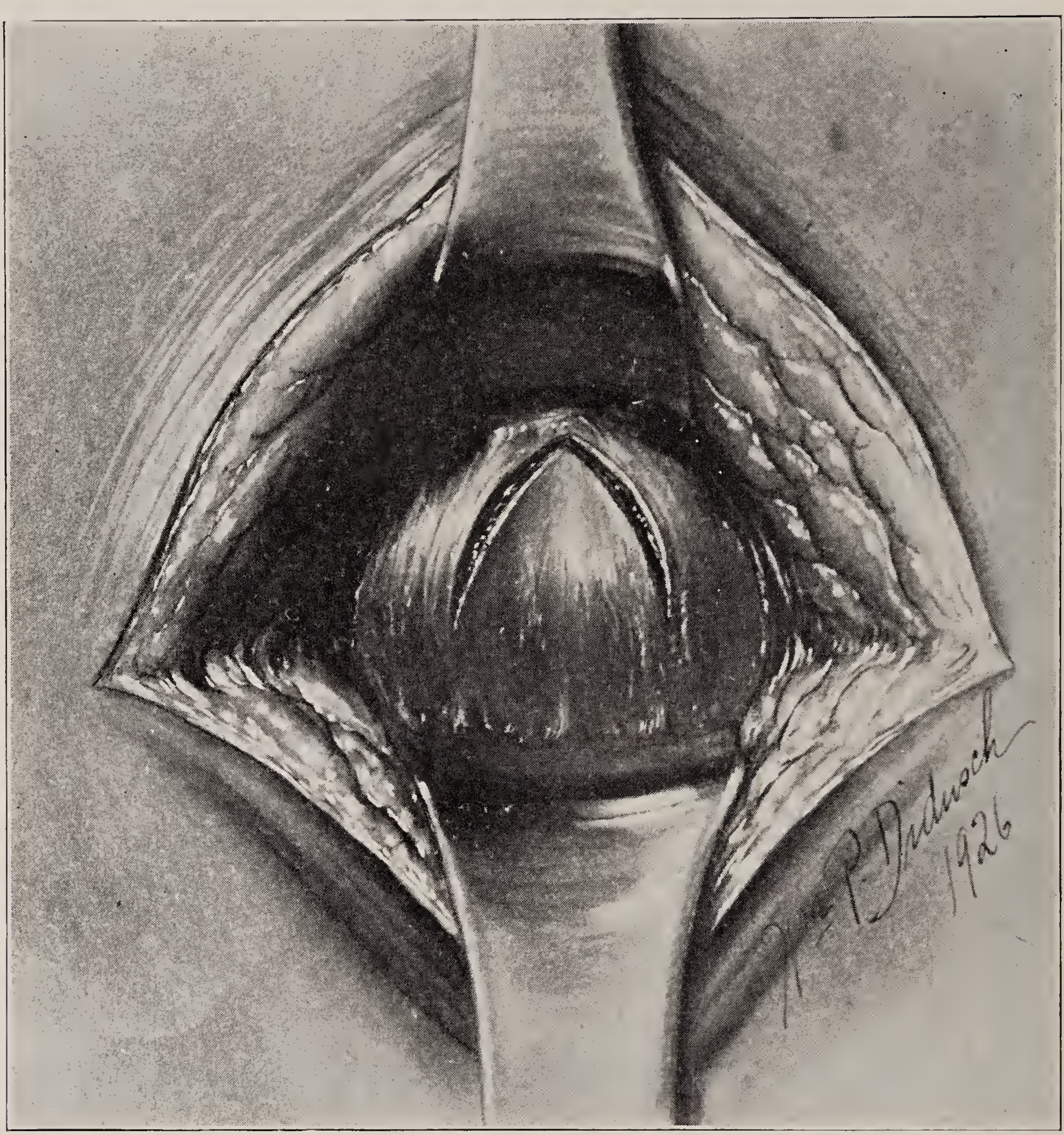

Fig. 58. Perineal prostatectomy. The entire posterior surface of the prostate having been dissected free, the finger is removed from the rectum, the glove changed, and a posterior tractor placed in position, thus drawing the rectum well out of harm's way. An inverted-V incision is now made in the posterior surface of the prostate, its apex being just at the apex of the gland, and is carried down to the posterior urethra. (From "Text-Book of Urology" by Lowsley and Kirwin, published by Lea & Febiger.)

made in front of the verumontanum and deepened in such a manner as to separate the median lobe from the posterior lobe with its dividing fibrous leaflet which conveys the ejaculatory ducts through the prostate. The ejaculatory ducts are thus left uninjured and

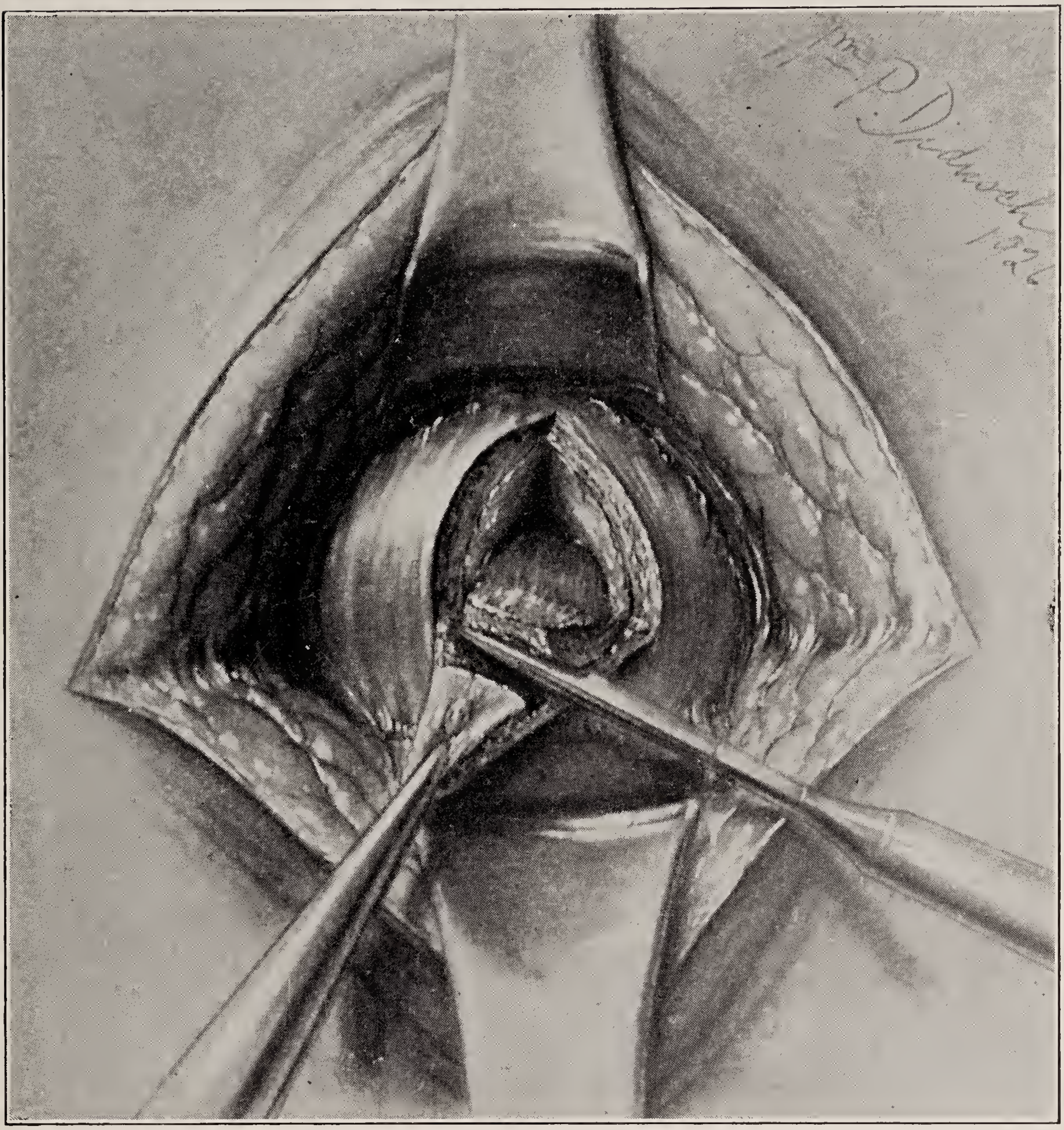

Fig. 59. Perineal prostatectomy. Showing inverted-V incision through the posterior and median lobes of the prostate and into the posterior urethra. Retraction of the V-shaped flap reveals the intact verumontanum. A transverse incision is made in front of the verumontanum and deepened in such a way as to separate the median from the posterior lobe, with its dividing fibrous leaflet which conveys the ejaculatory ducts through the prostate. The ejaculatory-duct orifices and the ducts themselves are thus retained intact — an important factor in the prevention of epididymitis. (From "Text-Book of Urology" by Lowsley and Kirwin, published by Lea & Febiger.)

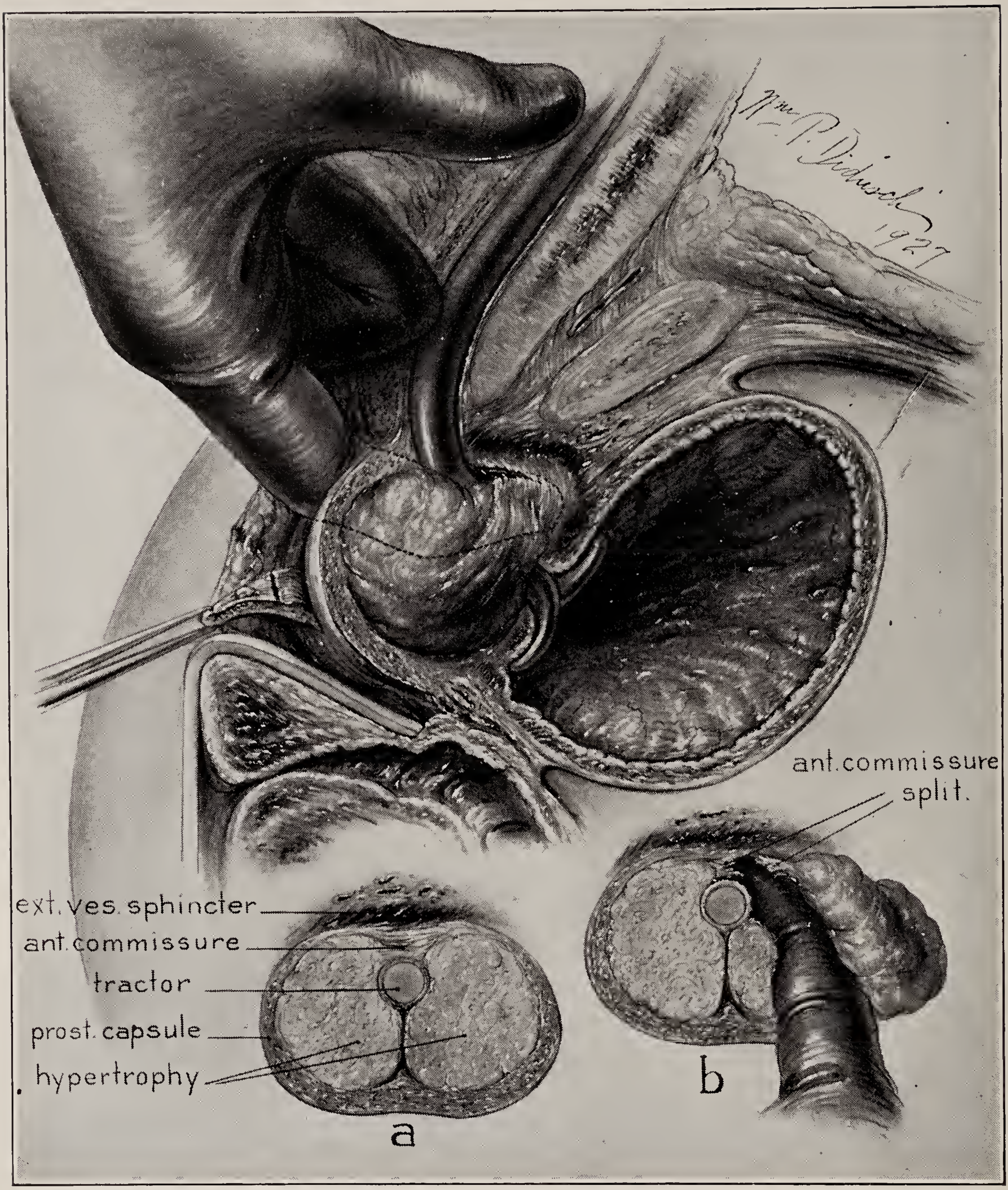

FIG. 60. Perineal prostatectomy. Sagittal view showing the index finger introduced through the V-shaped incision in the posterior surface of the prostate into the urethra, beside the tractor, and splitting the anterior commissure, care being taken not to injure the vesical sphincter. The enucleation is continued by sweeping the finger outward and downward on each side until the enlarged gland is freed. It is then removed by grasping it with the author's prostatic clamp. A No. 24-F. Foley catheter is introduced into the bladder through the urethra and secured by filling the retaining bag. (a) Cross section of the enlarged lobes with the tractor in position. (b) Cross section showing the finger separating the adenoma from the capsule.

retaining their normal orifices, which accounts for the low incidence of epididymitis following our technic. The enucleation of the gland is continued by separating the presenting hypertrophied portion from the capsule. The index finger is inserted into the prostatic urethra and the anterior commissure split, care being taken not to injure the internal sphincter any more than is absolutely necessary. Should the sphincter be split at the top, there is grave danger of tearing into the plexus of Santorini, with resulting hemorrhage. The hypertrophied mass is now grasped with the Lowsley clamp and the enucleation completed.

The vesical orifice is grasped with an Allis clamp, the Lowsley tractor is closed and removed, and the finger is introduced into the vesical orifice to identify and remove any fibrous tags, small nodules of prostatic tissue, or a subcervical gland enlargement. These half-destroyed tissues, if allowed to remain, constitute a future menace to the free passage of urine, or they may become necrotic and set up infection of the entire prostatic cavity. Pieces of prostatic tissue of considerable size can be removed with the Lowsley clamp through the vesical orifice without difficulty. A No. 24–F. Foley catheter is introduced into the bladder through the urethra and secured by filling the small encircling bag.

The membranous urethra, just external to the apex of the prostate, is plicated by the insertion of a mattress suture of ribbon gut, which greatly reduces the chances of postoperative incontinence of urine.

The vesical orifice and prostatic capsule are packed with sufficient vaseline gauze to arrest any bleeding. The floor of the pelvis is closed by approximating the two ends of the levator ani muscle with one or two sutures of chromic catgut, the subcutaneous tissue is closed with plain catgut, and the skin with interrupted silk or dermal sutures.

The gauze is removed in 24 hours or less ordinarily. The removal of the packing must be done very gently as otherwise the pain is excruciating. It is sometimes necessary to give gas for this procedure.

The wise surgeon stops the hemorrhage at the time of operation, before the wound is sutured. To rest in the hope that further packing or other manipulations might be accomplished in case the patient continues to bleed for several hours after operation is likely to prove disastrous inasmuch as even slight manipulation causes pain, and very slight pain, inflicted at a time when the patient is

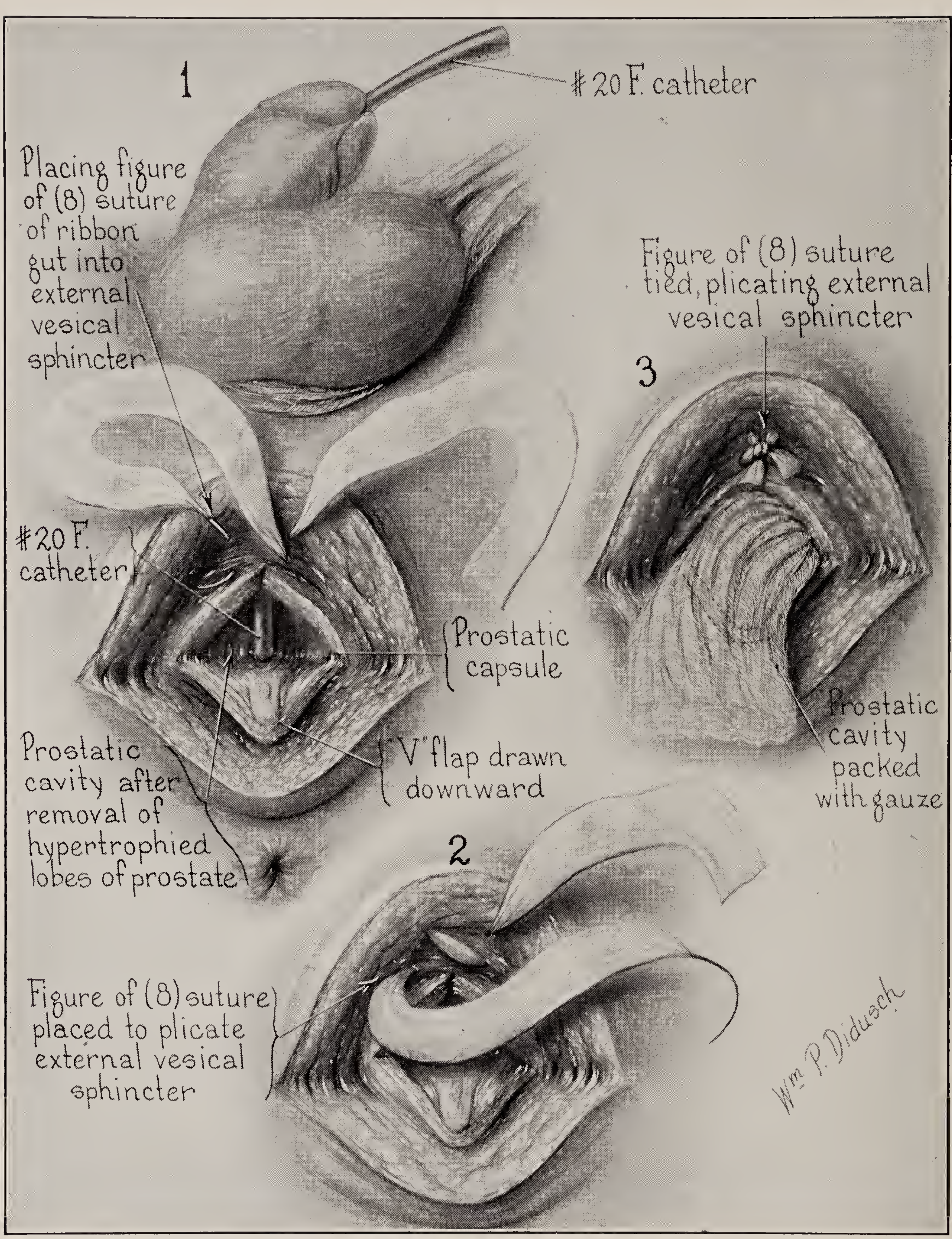
1
#20 F. catheter
Placing figure of (8) suture of ribbon gut into external vesical sphincter
#20 F. catheter
Prostatic capsule
Prostatic cavity after removal of hypertrophied lobes of prostate
"V" flap drawn downward
3
Figure of (8) suture tied, plicating external vesical sphincter
Prostatic cavity packed with gauze
2
Figure of (8) suture placed to plicate external vesical sphincter
Wm. P. Didusch

FIG. 61. Perineal prostatectomy. Plicating the membranous urethra, just external to the apex of the prostate, with ribbon gut, following perineal prostatectomy, helps to prevent incontinence of urine. (From "Clinical Urology" by Lowsley and Kirwin. Courtesy of The Williams & Wilkins Company, publishers.)

in a state of depressed blood pressure, will have a profound effect and may even throw him into shock. Control of hemorrhage is easily accomplished in perineal prostatectomy because bleeding points can be seen, clamped, and ligated in a satisfactory surgical manner. The general ooze which always occurs is controlled by packing the cavity of the prostatic capsule lightly with vaseline gauze. A cavity that is packed too tightly will attempt to expel the foreign body, and the resulting spasmodic contractions tend to cause continued hemorrhage.

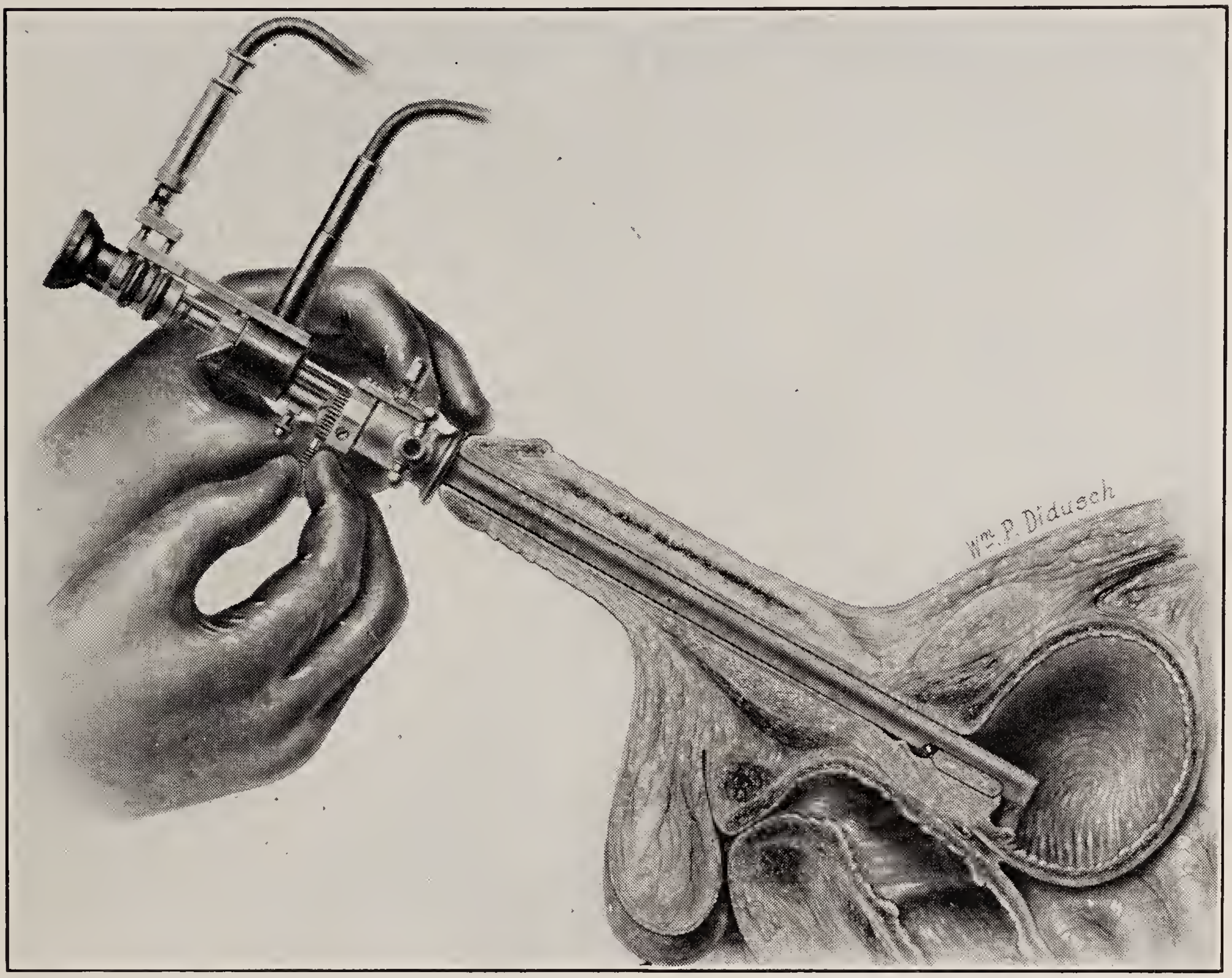

FIG. 62. Transurethral resection of the prostate, using the Kirwin resectoscope. Sagittal view showing the instrument in position. The median lobe has been engaged in the fenestra and the electrode is removing tissue. The left hand holds the instrument in position, the shaft being greatly elevated during resection on the median lobe. The right hand is slowly rotating the lever, thereby causing a rotary motion of the electrode resecting the median lobe. (Courtesy of American Journal of Surgery.)

Transurethral resection of the prostate. *Resectoscopes.* At present there are available a number of different types of highly perfected resectoscopes, including those of McCarthy, Stern-Davis, Caulk, Bumpus, Foley, Collings, Luys, Nesbit, and Kirwin. The author has found the excellent rotary resectoscope devised by Dr. Thomas J. Kirwin of particular usefulness. This is equipped with the McCarthy foroblique telescope, permitting continuous and complete observation of the field of resection — a very important feature since it enables the operator to see where the obstruction at the vesical neck is located, and at just what point the electrode must be applied in order to secure hemostasis yet not carbonize the tissues. It also enables him to note every movement of the cutting electrode and the precise situation of each " bite " engaged in the fenestra, both before and after it is cut. The lever controlling the electrode is attached to a shaft so that it can be

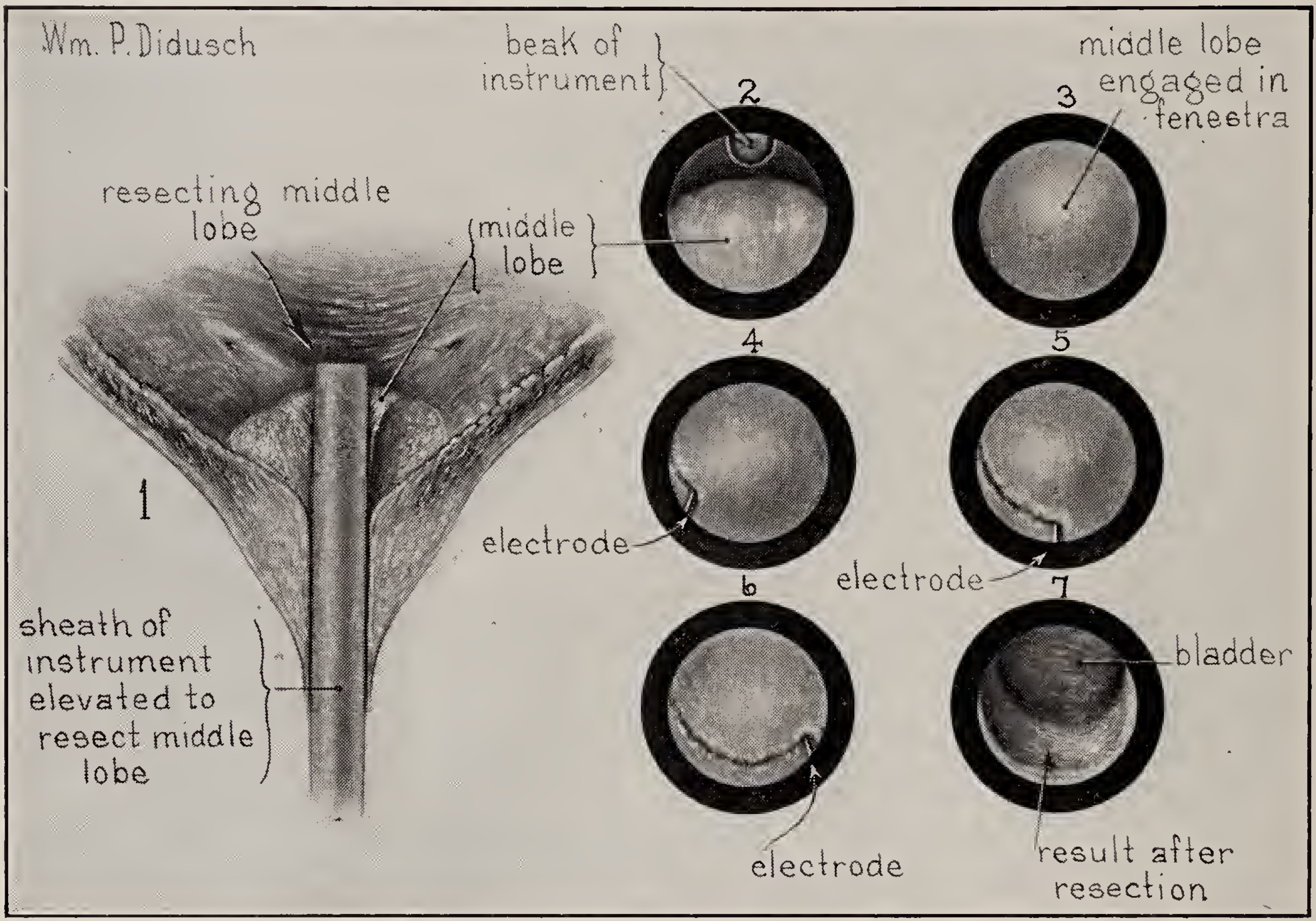

FIG. 63. Transurethral resection of the prostate; Kirwin resectoscope. Resecting the median lobe. (1) The bladder at the vesical orifice. The cutting electrode is downward and cannot be seen. In resecting the median or posterior portion of the vesical orifice, the shaft of the instrument must be greatly elevated in order to engage tissue in the fenestra. (2 to 6) Cystoscopic view of resection carried out on the median lobe. (7) The result after resection, showing the bladder and a large groove through the prostate gland. (Courtesy of American Journal of Surgery.)

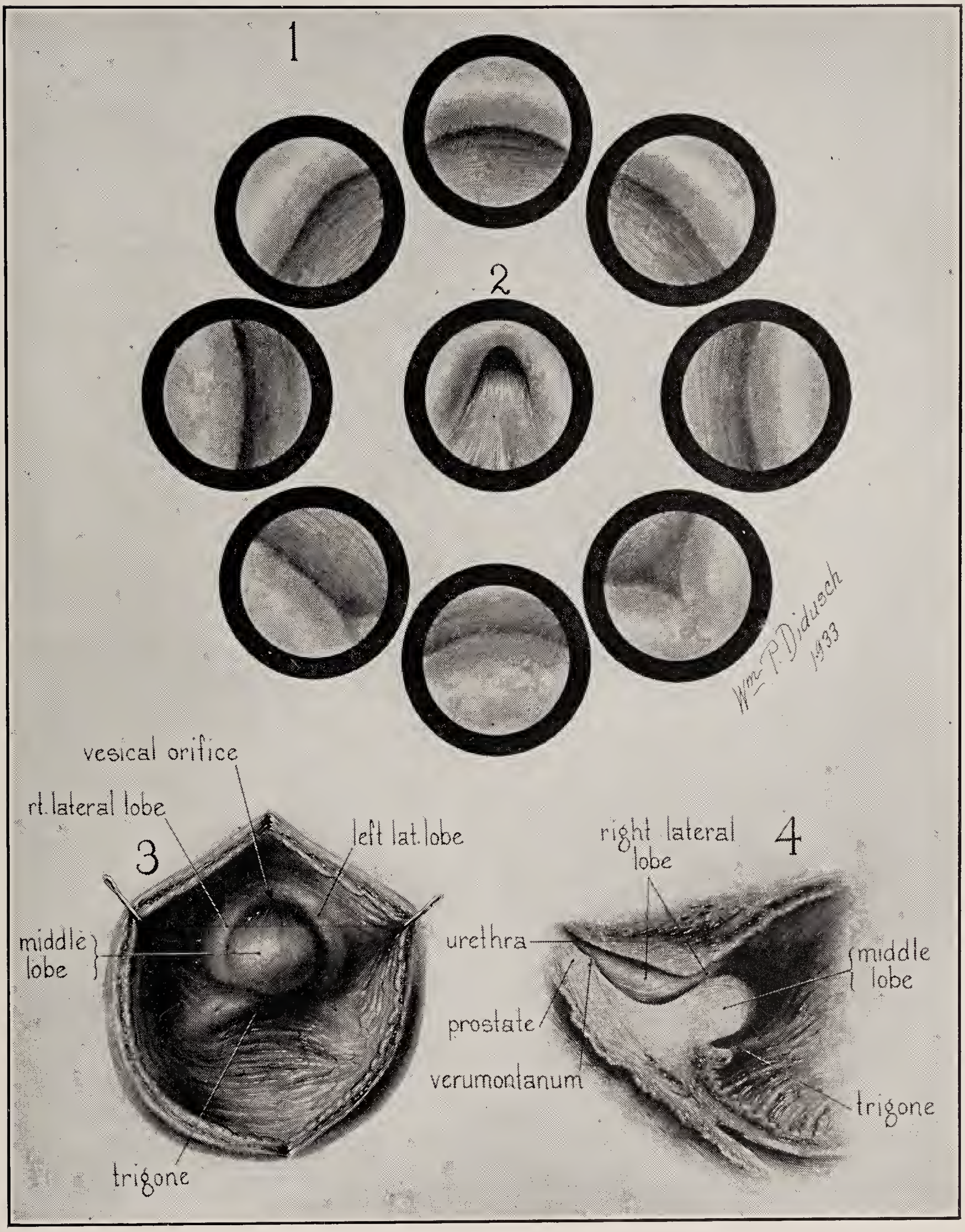

Fig. 64. Transurethral resection, using the McCarthy resectoscope. Showing a subcervical group enlargement, which is suitable for resection. (1) The cystoscopic picture. (2) The vesical orifice. (3) The intrusion of the subcervical group into the bladder on the floor of the vesical orifice. (4) Sagittal view of the intrusion. (Courtesy of Dr. Robert W. McKay.)

rotated in either direction with equal facility. The eccentric swing of the rotating wire cutting electrode at its highest point changes the caliber of the instrument from a No. 28 to a No. 32–F. This permits the use of a sheath several sizes smaller than would otherwise be possible while obtaining so large a cut, thus obviating trauma to narrow urethras.

Technic. The technic of transurethral prostatectomy varies somewhat with different operators, as well as with the instrument employed. The general principles, however, are the same irrespective of which instrument is selected. The technic described here is that followed when the Kirwin resectoscope is used.

With the patient in the lithotomy position, the instrument is inserted and the field of resection oriented. The ureteral orifices are first located and the center of the interureteric ridge, midway between them, ascertained. The instrument is then withdrawn somewhat and the precise position of the verumontanum established. Between these two structures lies the field of resection, and the avoidance of injury to either of them is of the greatest importance.

When the median and lateral lobes are all enlarged, one of the lateral lobes should be resected first. Removal of the median lobe first will cause the two lateral lobes to collapse toward each other, which not only makes it difficult to control bleeding but hampers the efficient removal of the remaining tissue. If the left lateral lobe is to be resected first, the shaft of the instrument is carried well to the patient's right side, thus forcing the tissue into the fenestra. When this is accomplished, the beak of the instrument is no longer within the visual range, indicating that the lobe is in position to be resected. The cutting arc passes from left to right. The cut completed, the obturator carrying the cutting electrode is unlocked, rotated, and withdrawn, bringing with it the resected piece of tissue. A field clear of débris is thereby insured, and visual evidence of the amount of tissue resected is constantly in view. The procedure is repeated on the other lobes until the proper amount of obstructive tissue has been removed — that is, until the operator can see an unobstructed passageway from the verumontanum to the interureteric ridge. The amount of tissue which must be taken out in order to open such a passageway depends not alone on the size of the median lobe but, even more, upon the amount of lateral-lobe intrusion. In resecting the middle or posterior portion of the vesical orifice, the shaft of the instrument

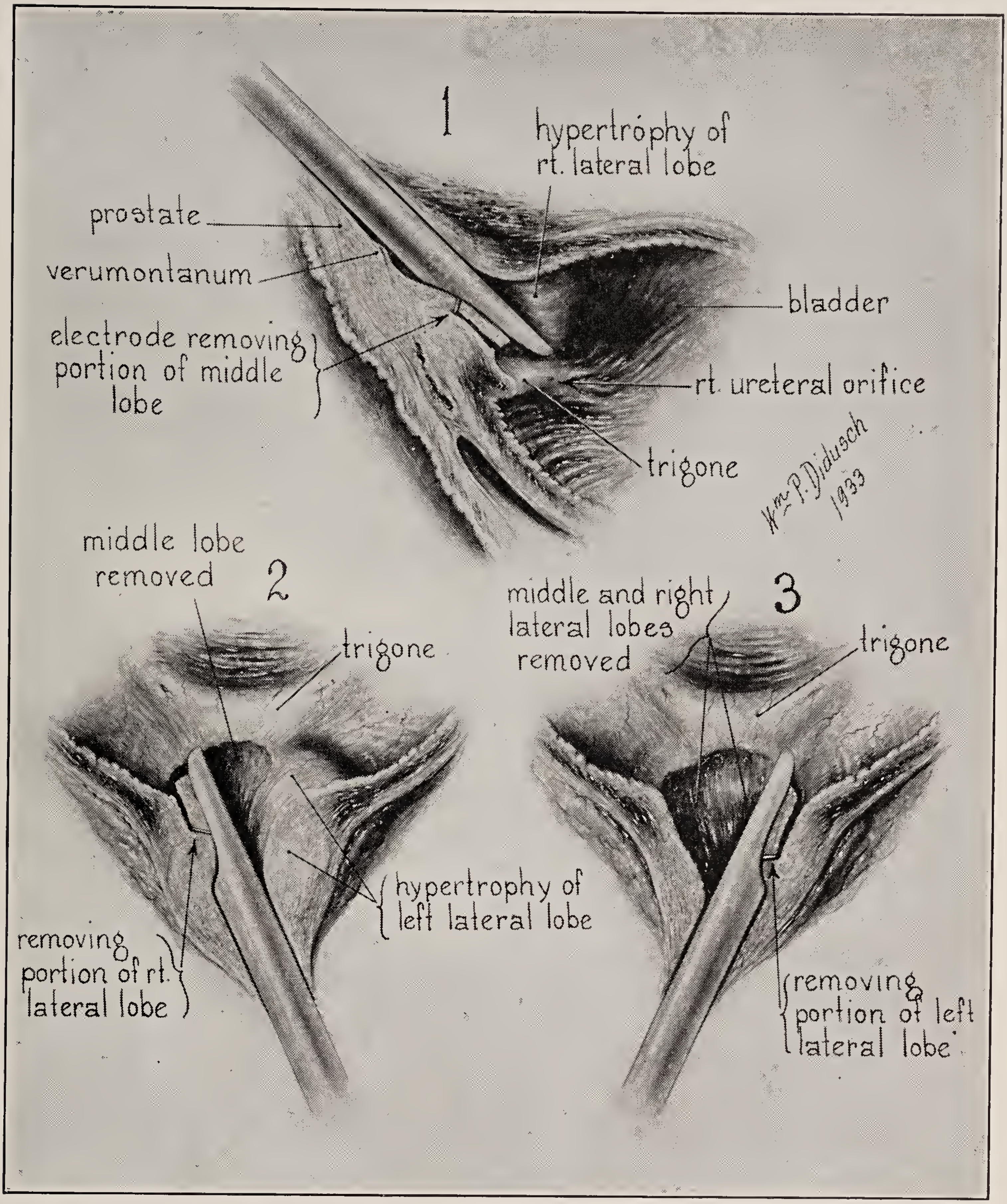
1
hypertrophy of rt. lateral lobe
prostate
verumontanum
bladder
electrode removing portion of middle lobe
rt. ureteral orifice
trigone
Wm P. Didusch 1933
middle lobe removed
2
trigone
middle and right lateral lobes removed
3
trigone
hypertrophy of left lateral lobe
removing portion of rt. lateral lobe
removing portion of left lateral lobe

FIG. 65. Transurethral resection; McCarthy resectoscope. (1) Removing a portion of the median lobe. (2) Removing part of the right lateral lobe and (3) of the left lateral lobe. (Courtesy of Dr. Robert W. McKay.)

must be greatly elevated in order to engage the tissue in the fenestra.

The resection completed, a whistle-tip catheter is introduced, or, if there is considerable edema of the surrounding tissue, a wing-tipped catheter with a stylet.

Postoperatively, a urethral catheter is kept in place until all blood has disappeared from the urine — usually a period of from 3 to 5 days. This should be irrigated once a day as there is a considerable amount of slough which must be kept out of the bladder. A urinary antiseptic, such as methenamine or one of the sulfonamides, is given orally to prevent the rapid growth of bacteria. Sulfadiazine, in conservative doses, has proved particularly useful in preventing or combating nonspecific infections of the bladder following transurethral resection.

Postoperative care of the prostatectomy case. The postoperative care is of supreme importance in the prostatectomy case. A well-trained nurse is invaluable in this care, and her keen observation may save many a life when complications arise, as they frequently do irrespective of which method is employed.

If the patient has had spinal anesthesia in any form, his head must be kept lowered for at least 6 hours so that the anesthetic will not reach the vital centers of the brain and cause respiratory failure. The patient should be instructed to keep his head flat on the bed in order to prevent severe headache. A hair pillow should be strapped to the head of the bed to prevent the patient's head from coming in contact with the bars when he is placed in the Trendelenburg position. At the end of 6 hours the shock blocks are removed, the patient placed in a horizontal position for 12 hours, and the importance of keeping his head lowered during this period again impressed upon him. Elderly patients, in particular, should be turned from side to side occasionally while in the Trendelenburg position and after the bed is lowered, to prevent hypostatic pneumonia and to stimulate the circulation as a preventive against the formation of thrombi. Shallow and infrequent respirations may be changed to deep, regular respirations by 5-minute inhalations of oxygen and carbon dioxide at frequent intervals.

Blood-pressure estimation is the most important single item in the observation of the patient for the first 24 hours. The blood pressure should be taken every hour until it has passed through its period of depression and again risen to a safe level. Both hemorrhage and the rise in blood pressure are much less in prostatectomy

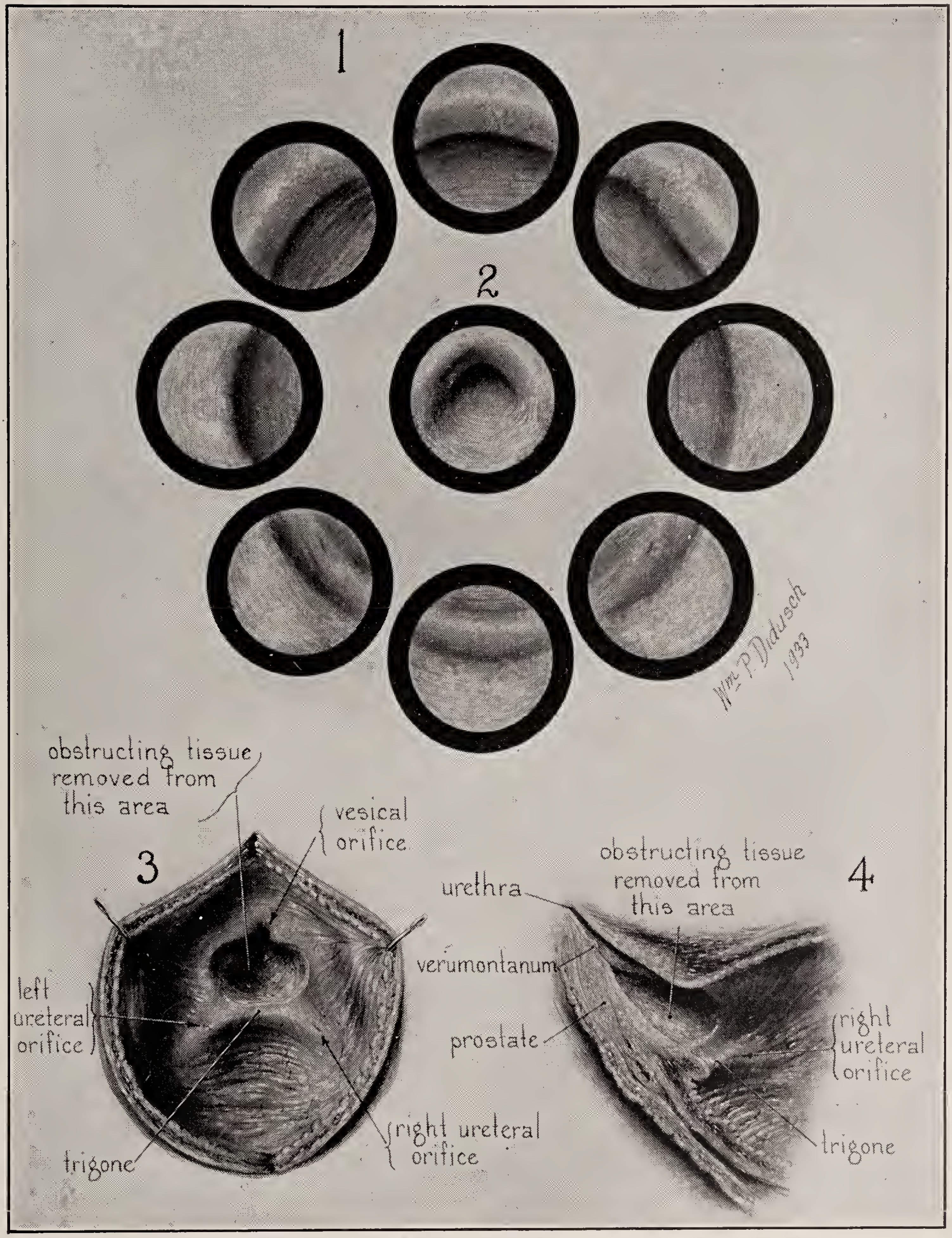

FIG. 66. Transurethral resection; McCarthy resectoscope. (1) The cystoscopic picture after resection. (2) The vesical orifice with the obstruction removed. (3) The view of the resected area from within the bladder. (4) Sagittal view of resected area. (Courtesy of Dr. Robert W. McKay.)

under regional anesthesia than in operation under any of the inhalation anesthesias.

Postoperative hemorrhage may occur, however, in spite of the utmost care at the operating table, and is only dealt with by prompt and efficient cauterization or packing. If the patient has a suprapubic wound, the tube may be removed, with the finger in the rectum as a guide, and the site easily repacked if necessary; but in a one-stage perineal prostatectomy a more difficult problem presents itself and must be dealt with as indicated. Often suprapubic cystostomy is the measure of choice. Postoperative hemorrhage may also occur after transurethral prostatectomy, despite every care, and is dealt with by exerting pressure upon the perineum by packing, evacuating the clots through a large catheter, and irrigating the bladder with silver nitrate solution, 1:5,000. Rarely it may be necessary to resort to suprapubic cystostomy in order to do this. When hemorrhage is slight, intravenous infusions of saline, glucose, or gum-glucose are administered; but if the bleeding is more extensive a transfusion of properly tested blood is indicated.

Shock is induced by loss of blood, pain, injury to the nervous mechanism, or, frequently, by certain toxic substances. It is marked by very low or imperceptible blood pressure, cold, clammy skin, pallor, and rapid, shallow breathing. Since the adoption of regional anesthesia in our prostatic operations, shock has almost disappeared from our wards. The ordinary methods of combating shock are familiar to everyone. They consist of raising the foot of the bed, keeping the patient warm, and administering fluids and stimulants by mouth and rectum. Salt solution, given intravenously, raises the blood pressure in from 30 to 50 minutes, and in slight shock this is often enough to tide the patient over. We prefer, however, the intravenous injection of a 50 per cent. solution of glucose. Blood transfusion may be necessary in extreme cases. An important thing to remember in shock is that many a person has been killed by kindness. All the various ways of bedeviling a sick man, by unnecessary hospital routine measures, should be scrupulously avoided. More patients have been brought out of shock by intelligent "neglect," after proper methods of stimulation have been instituted, than by elaborate methods which constantly annoy the shocked patient.

Postoperative pain should be avoided by every means possible. When spinal anesthesia with procaine has been used, the anesthetic effect continues to a certain extent for from 6 to 8 hours so that the patient is tided over the trying period of depression and usually sleeps well the night after operation.

Abdominal distention should be promptly attended to. It may be relieved by frequent turning, the use of a rectal tube, small carminative enemas, intramuscular injections of 1 cc. of pitressin, or 1 cc. of prostigmin, 1:4,000.

The urinary output of the prostatic patient is of the utmost importance. The chief object of the preoperative treatment is the securing of good drainage. Postoperatively, the urinary output is carefully observed and prompt measures are instituted to stimulate the kidneys to increased activity if they appear sluggish. This is accomplished by infusions of normal saline, with or without glucose, and by the use of drugs such as potassium citrate, caffeine, and thyroid residue.

Fluids should be given in increasing amounts as soon as the immediate effects of the operation have worn off. Generally speaking, prostatic patients should take from 3,000 to 4,000 cc. of fluids daily. Since, as a rule, there is little or no vomiting following regional anesthesia, small amounts of fluid should be given almost immediately.

The drainage tube, in suprapubic cases, is usually removed on about the sixth day, drainage thereafter being maintained by means of a tube in the urethra until the suprapubic wound is healed. In perineal cases the drainage tube is now inserted through the urethra and is left in until the wound is healed. Following transurethral prostatectomy, a urethral catheter is kept in place for about 3 to 5 days, or until all blood has disappeared from the urine. The bladder is irrigated daily to remove all slough.

Perineal irrigation following perineal prostatectomy keeps the perineal area clean and relieves any pain and inflammation. The soiled dressing is removed and the perineal area is cleansed with green soap solution. It is then irrigated with warm hydrogen dioxide, rivanol dextrose, 1:2000, bichloride of mercury, 1:1,000, or oxycyanide of mercury, 1:1,000, and a fresh sterile dressing applied.

Maintaining the patient in a semi-erect position as soon as possible after the operation is very important, not only because the upright position favors drainage and has a good effect psychologically, but because the danger of hypostatic pneumonia is greatly lessened by these elderly patients sitting up, first in bed and then in a chair. *Following perineal prostatectomy*, the patient is usually allowed to sit up in bed for half an hour on the third or fourth day, a careful examination of his legs and thighs first having been made to make sure that no thrombus is present. The author feels that if this examination were general, many a fatality due to embolus might be avoided by recognition of the condition. The patient is kept lying quietly in a semi-reclining position for several days longer, and should be prevented from straining at stool as fatal emboli are sometimes dislodged by such efforts. He is encouraged to sit up in a chair on the sixth or seventh day, a tight binder having first been applied so that the wound will not be interfered with. If he stands it well, he should be allowed to remain up for 20 to 30 minutes, and, as his condition improves, he should be encouraged to take short walks around his room. These slight but gradually prolonged activities will accustom his heart to future activities and are most important in the patient's convalescence. *Following suprapubic operation*, a urethral catheter is inserted about the sixth postoperative day, and the patient is lifted from his bed on the seventh day, fitted with a tight binder, and permitted to sit in a chair for half an hour, this period being gradually lengthened.

Dilatation of the sphincter, by sounds or, preferably, by the Kollman dilator, is done three weeks after prostatectomy. This procedure is necessary to overcome the tendency to stricture of the vesical orifice due to contraction of the circular wound during healing and scar formation.

Postoperative complications. In addition to the complications already mentioned — hemorrhage, shock, and pneumonia — there are certain other factors which not infrequently complicate the postoperative course. Among these are *cardiac complications*. In patients who have been properly prepared for prostatectomy it is surprising how seldom a bad heart will begin to compensate, but occasionally this does occur, and one sees auricular fibrillation, dilatation, or heart block. When this occurs, the heart must be stimulated with appropriate drugs, and it is often advisable to put the patient in an oxygen tent. *Embolism* of a lung is a complication feared by every surgeon. It manifests itself by disturbed respiration, increased pulse rate, unconsciousness, cold, clammy skin, and other evidences of extreme shock. When it occurs the patient is always seriously embarrassed and often dies. Since both the circulatory and the respiratory systems are affected, it is usually necessary to stimulate the heart and put the patient in the oxygen chamber as well. *Acute gastric dilatation* is relieved by passing one of the many tubes into the stomach. The tube may be inserted through the nose and left in position for several days, if necessary, for the purpose of gastric lavage and the release of gases. *Ileus* sometimes occurs, and is usually relieved by colonic irrigations, the use of turpentine stupes, heat applied to the abdomen, and pituitrin. *Anuria* may occur postoperatively, and heroic measures are then necessary to start the secretion of urine. One or more of the following measures will usually prove successful: infusions of normal saline, with or without glucose, every 2 or 3 hours and not exceeding 500 cc. in amount; irrigations of the kidneys and bladder with warm solutions; the administration of certain drugs, such as potassium citrate, caffeine, and thyroid residue; and, in extreme cases, decapsulation of both kidneys. *Toxic nephritis*, manifested by dry tongue, fetid breath, vomiting, and diminished output of urine, should be treated by hot applications to the kidneys and high colonic irrigations, as well as by the measures advocated in anuria. *Urinary incontinence* and *recto-urethral fistula* occasionally complicate perineal prostatectomy even in the most skilful hands.

The addition of transurethral prostatectomy to the urologist's armamentarium has not eliminated any of the previous complications of prostatic surgery but has added two, namely *rupture of the bladder, with urinary extravasation*, and *traumatic stricture of the pendulous urethra*, a more remote complication due to too strenuous dilatation of narrow urethras in order that they may accommodate the resectoscopes in common usage, most of which are No. 28 or 29-F. in caliber. The infection and sepsis often seen during the immediate postoperative period are probably more frequently due to the introduction of bacteria foreign to the patient than to organisms harbored by him at the time of operation. Such infections can be largely reduced by the careful preparation of the patient for instrumentation and the aseptic care of catheters and other instruments.

Postprostatectomy follow-up. The postprostatectomy patient should be under the care of his surgeon for an indefinite period of time. Many of these elderly patients have cardiovascular, renal, and vesical lesions which are benefited but not cured by the restoration of the ability to void normally. The patient's diet and methods of elimination should be carefully supervised, and ample relaxation should be insisted upon. A complete vacation of several months is advisable following prostatectomy. Frequent dilatations with sounds or the Kollmann dilator, to prevent the formation of stricture at the vesical orifice, should be done. Many urologists have found hormonal therapy (testosterone) helpful in the care of these patients. A postprostatectomy patient may easily outlive his contemporaries if he is temperate in his appetites and regular and moderate in his habits of work and relaxation.

OPERATIVE TREATMENT OF CARCINOMA OF THE PROSTATE

Indications for operation. The treatment of prostatic carcinoma is discussed at length elsewhere (Treatment of Prostatic Carcinoma, p. 746 (88)); Radium and Roentgen-Ray Therapy of Prostatic Carcinoma, p. 746 (111–72A)). Briefly and in general: Early malignancy is best treated by radical perineal prostatectomy — the only method of treatment at present available which offers the patient a chance of permanent cure. The author's method of performing total prostatectomy, with removal of the seminal vesicles, is described on page 746 (111–56A).

In prostatic malignancies that have advanced beyond the hope of radical cure, the chief problems are the relief of urinary obstruction and the alleviation of pain caused by the primary tumor or by bony metastases. Obstruction may usually be relieved by either transurethral resection or conservative perineal prostatectomy, depending upon the indications. In certain cases suprapubic cystostomy may be advisable. Pain may often be relieved, and the growths may sometimes be controlled for considerable periods, by the use of radium or x-ray, or both. In advanced or disseminated prostatic carcinoma, castration effects marked clinical benefit, including alleviation of pain, in many cases. If the patient has had resection or prostatectomy for the relief of obstruction, orchidectomy is postponed until he recovers from the effects of the first operation.

Orchidectomy for prostatic carcinoma. The method which we use in performing orchidectomy on patients who have malignancy of the prostate is that suggested by Dr. Elmer Hess, of Erie, Pennsylvania.

The testicle is exposed in the usual manner, and an incision is made in the tunica albuginea. Pressure is made on this, and the testicular material pops out of the tunica (just as a grape would pop out of its skin under similar pressure), leaving the testicle attached at its upper part, where the rete testis is located. This is clamped and tied off, and the testicle is then cut away. The scrotum is closed in layers without suturing the tunica albuginea. Thus, a considerable mass of tissue, including the epididymis and the tunica albuginea, is left in the scrotum, which has a very desirable psychic effect on the patient.

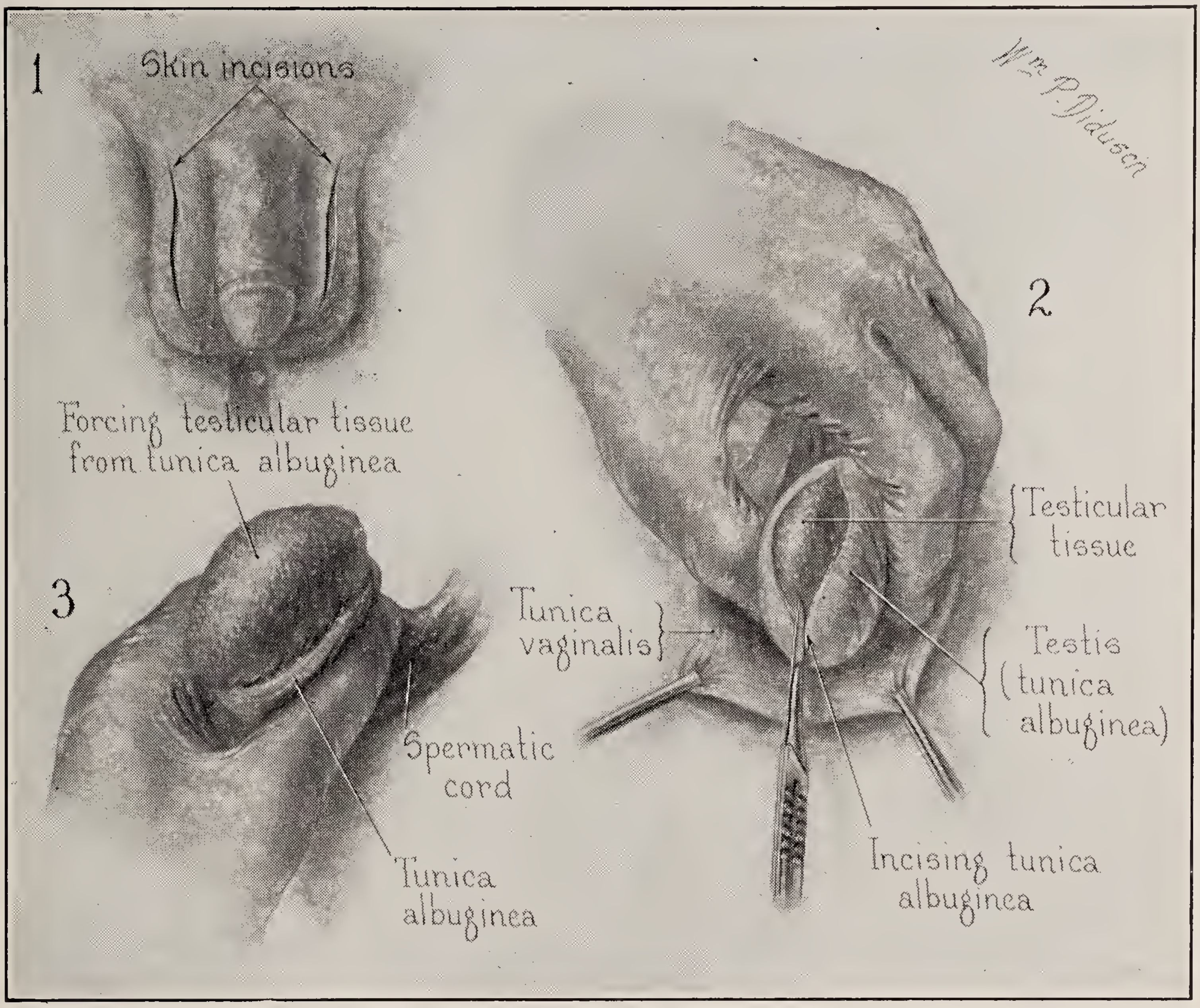
1
Skin incisions
Wm P. Didusch
2
Forcing testicular tissue from tunica albuginea
3
Testicular tissue
Tunica vaginalis
Testis (tunica albuginea)
Spermatic cord
Tunica albuginea
Incising tunica albuginea

FIG. 67. Orchidectomy for prostatic carcinoma; technic of Dr. Elmer Hess. (1) Skin incisions. (2) Incising the tunica albuginea. (3) Forcing the testicular tissue from the tunica albuginea, leaving the testis attached at its upper part.

OPERATIVE TREATMENT OF PROSTATIC ABSCESS

Methods employed. Many methods of draining prostatic abscesses have been proposed, including evacuation by the transvesical route, transurethral resection, needle aspiration through the perineum with the finger in the rectum as a guide (Barringer), and rupture of the abscess by means of a sound passed through the urethra (Stevens). None of these methods has been found completely satisfactory. Productive of much better results is surgical evacuation through the perineum, either by exposure of the prostate and prostatotomy, or by external urethrotomy, as the circumstances may indicate.

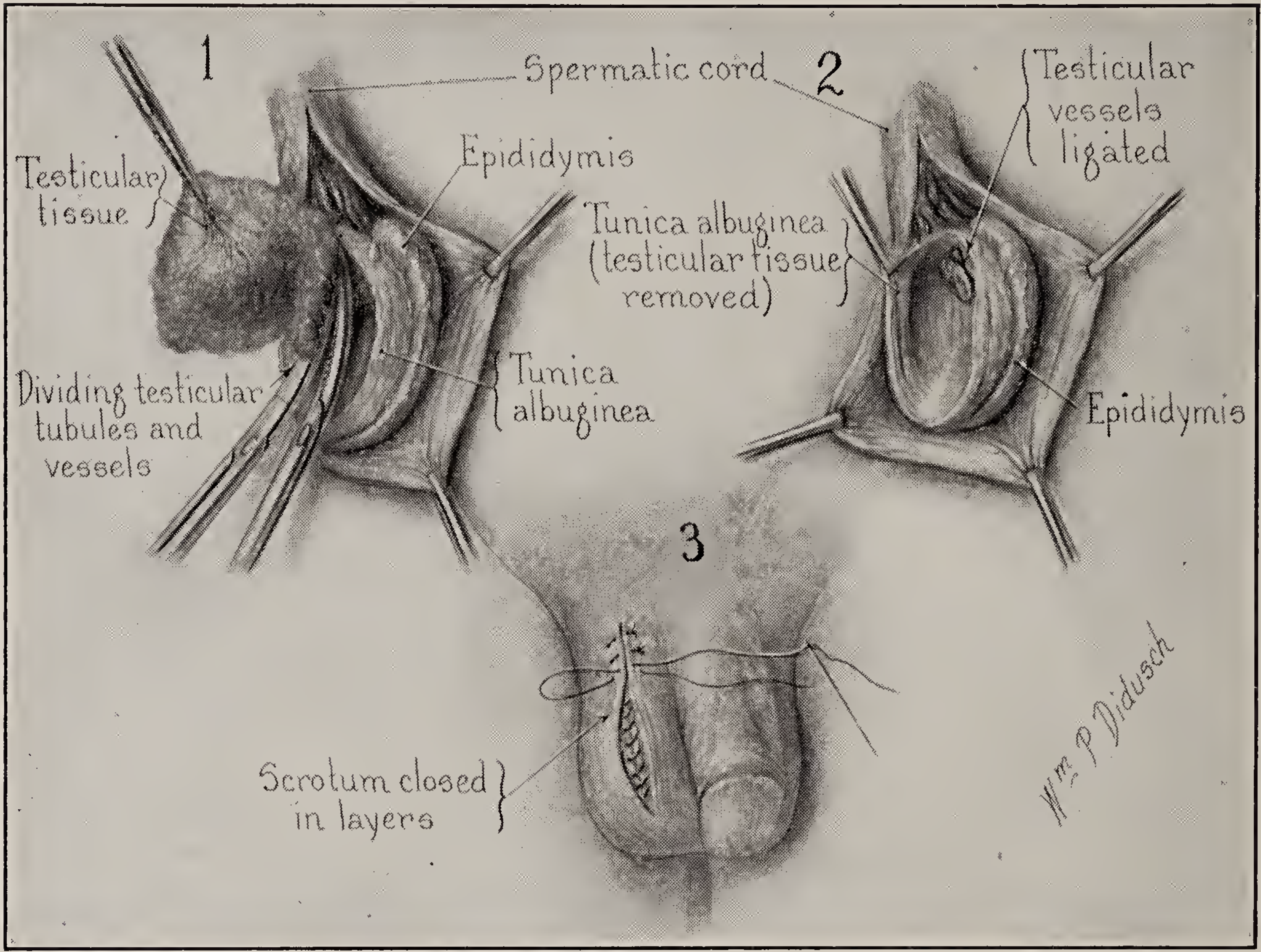
1
Spermatic cord
2
Testicular vessels ligated
Testicular tissue
Epididymis
Tunica albuginea (testicular tissue removed)
Tunica albuginea
Dividing testicular tubules and vessels
Epididymis
3
Scrotum closed in layers
Wm. P. Didusch

Fig. 68. Orchidectomy for prostatic carcinoma. (1) A clamp has been applied to the testicular vessels, and the testicle is being excised. (2) Showing result after removal of the testicular tissue. The testicular vessels have been ligated. (3) Closure of the scrotum.

Evacuation of prostatic abscess through posterior urethra (**external urethrotomy**). This method is preferable when there is a strictured urethra. A Lowsley tractor or a sound is introduced into the urethra, and a midline incision is made in the perineum. The bulbous urethra is exposed and incised longitudinally upon the tractor. The finger is introduced into the prostatic portion of the urethra and thence through the urethral wall into the abscess

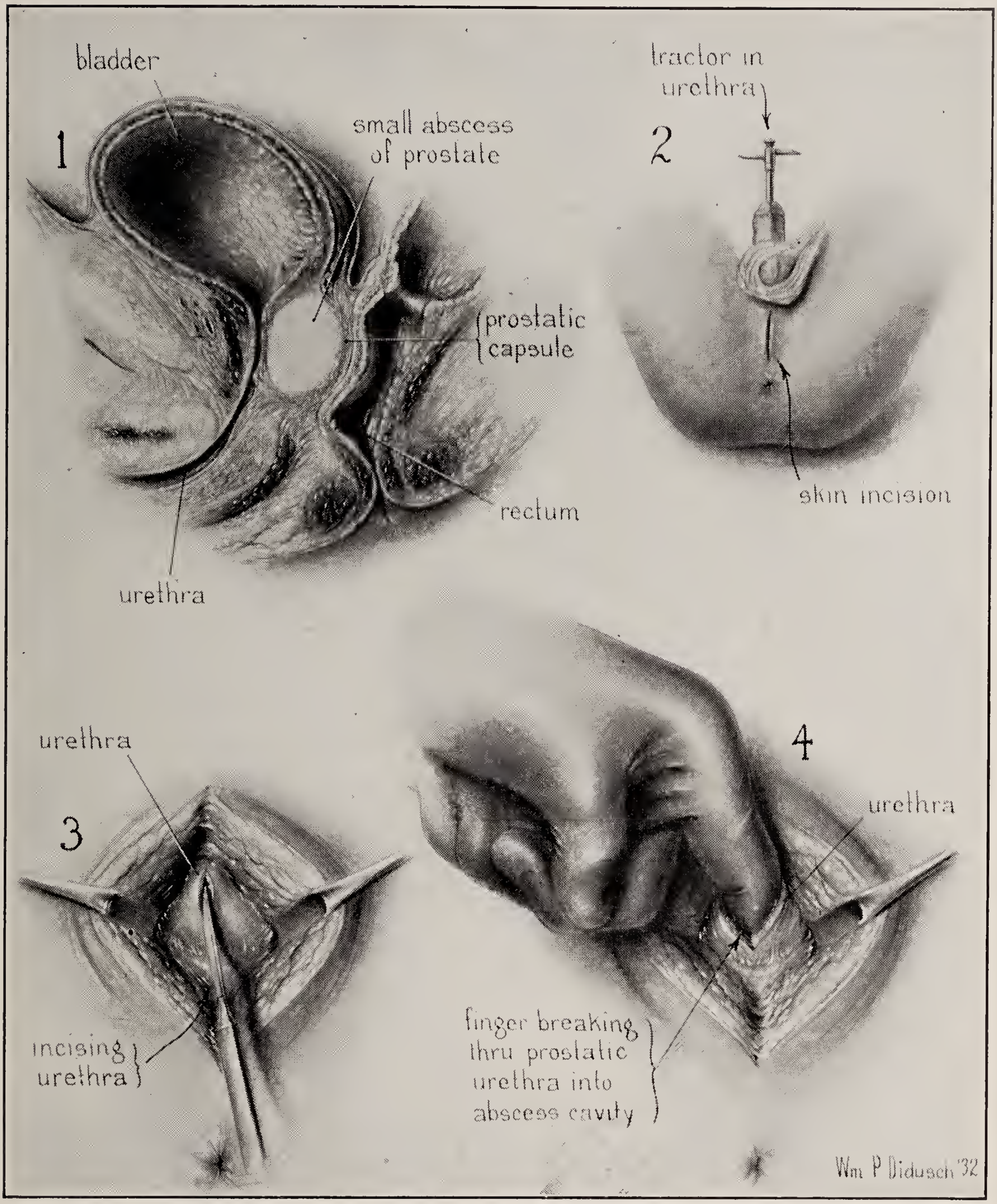

FIG. 69. Evacuation of small prostatic abscess through posterior urethra. (1) Sagittal view showing small abscess of the prostate. The abscess causes slight bulging into the rectum, and the capsule is thinned out by the pressure from within. (2) A tractor or sound is introduced into the urethra and a midline incision made in the perineum. (3) The urethra is exposed and incised upon the tractor. (4) The finger is inserted into the prostatic urethra and through the urethral wall into the abscess cavity, evacuating it. (From "Clinical Urology" by Lowsley and Kirwin. Courtesy of The Williams & Wilkins Company.)

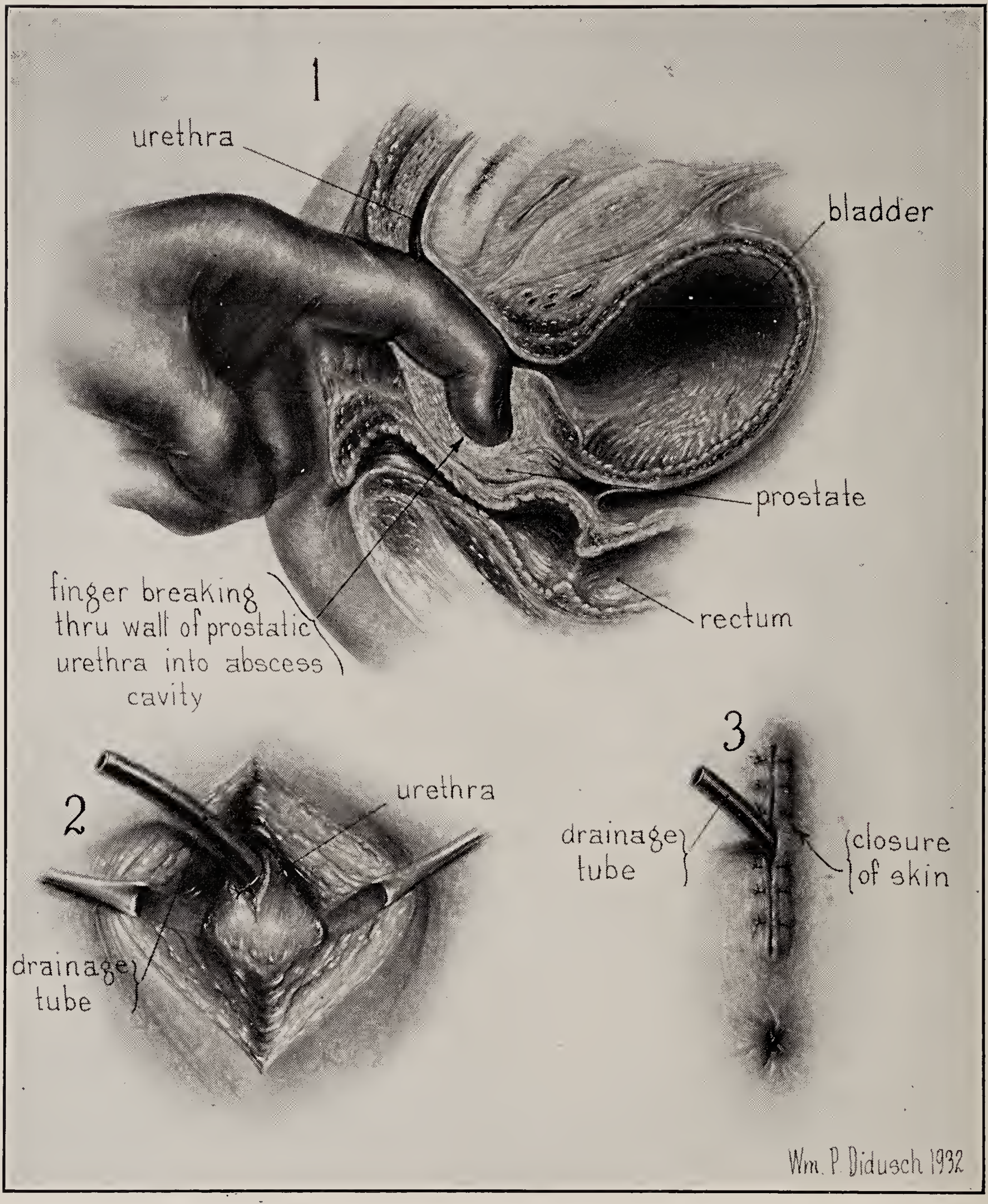

FIG. 70. Evacuation of small prostatic abscess through the posterior urethra. (1) Sagittal view showing the finger breaking through the urethral wall into the abscess cavity. (2) A drainage tube is inserted into the urethra and secured in position. (3) The skin is closed with interrupted mattress sutures. (From "Clinical Urology" by Lowsley and Kirwin. Courtesy of The Williams & Wilkins Company.)

cavity, and the honeycombed interior is cleaned out so that no pus-filled pockets remain. The abscess cavity is then thoroughly irrigated and drainage established by means of a tube introduced through the urethrotomy incision, which diverts the urine and conducts the pus out through the perineal wound. The skin is closed about the tube with interrupted mattress sutures.

Evacuation of prostatic abscess from outside the urethra (**prostatotomy**). When there is no stricture of the urethra, and particularly when the abscess is located in the posterior lobe, perineal exposure of the prostate and prostatotomy is preferable. A tractor is introduced into the urethra, and an inverted-V incision is made in the perineum. Through this the intervening tissues are carefully dissected apart until the suppurating prostate is exposed to view. It is then possible to see in what direction the abscess is pointing, and to incise and evacuate it, or, if the tissues are badly damaged, to do a partial prostatectomy. A drainage tube is inserted in the prostate through the capsular incision and the skin closed about the tube by mattress sutures.

OPERATIVE TREATMENT OF PROSTATIC CALCULUS

Methods employed. Symptom-producing prostatic calculi require surgical removal. There are several methods of accomplishing this, the choice of operation depending upon the age of the patient, the number, size, and location of the stones, and the presence and nature of other concomitant prostatic disease.

Younger men with multiple stones in their prostates should be treated by prostatotomy as a rule. The perineal approach is the method of choice; but the suprapubic route is occasionally chosen in the belief that it is less likely to traumatize the bladder sphincters. The author's own choice, when the patient is still sexually active and is not suffering from benign hypertrophy, is to expose the prostate as for a perineal prostatectomy, make an incision into the gland through the posterior capsule, and remove the calculi with a curette, with as little destruction of prostatic tissue as possible.

Transurethral resection is frequently employed when there is slight enlargement of the subcervical group of tubules associated with small or medium-sized calculi, both the stones and the subcervical group being removed with the resectoscope. This method is sometimes also employed when there is no associated hypertrophy. Because it does not result in impotence or sterility, it is

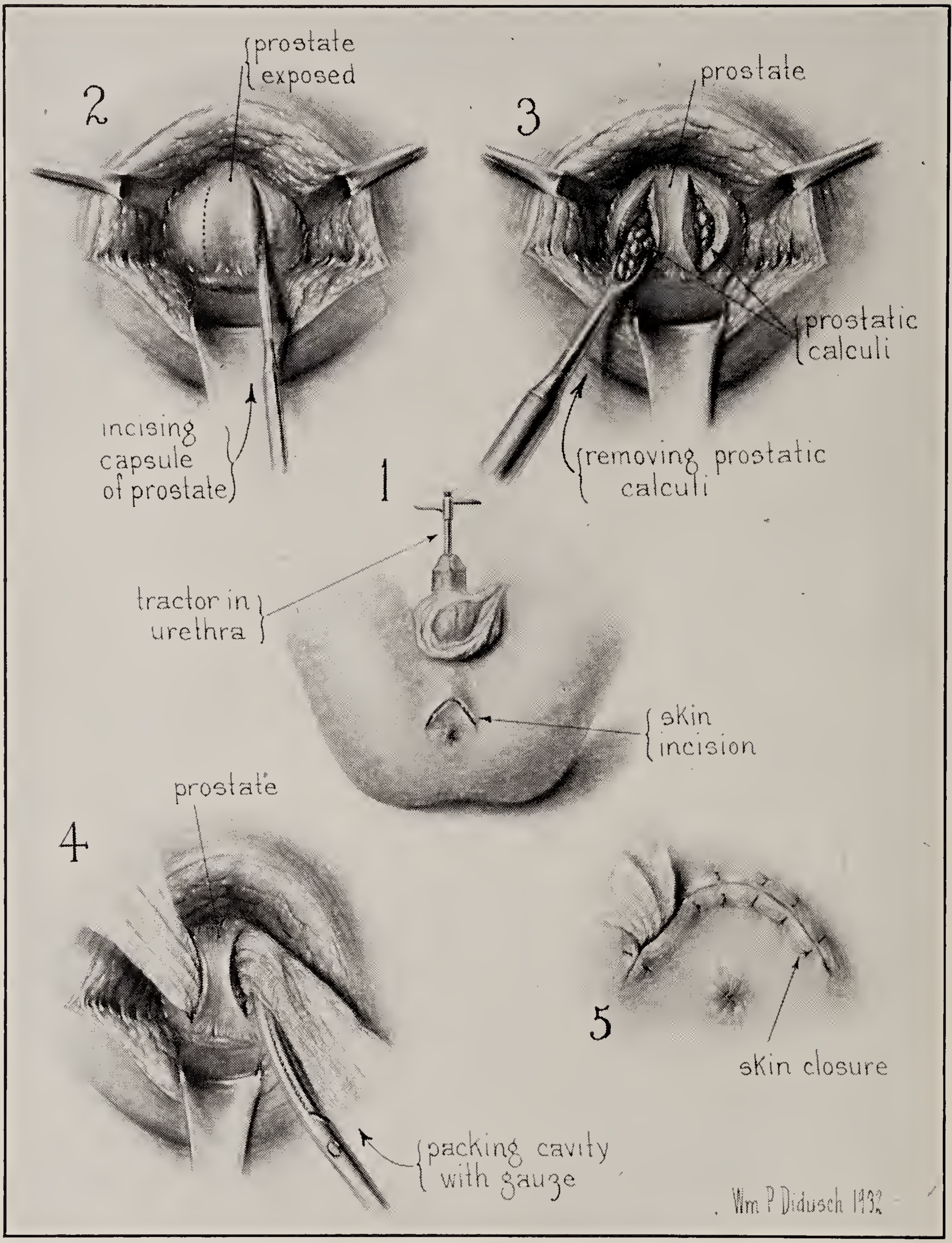

FIG. 71. Prostatotomy for the removal of calculi. (1) A prostatic tractor having been inserted into the urethra, an inverted-V incision is made in the perineum. (2) The prostate is exposed as in perineal prostatectomy. Two parallel incisions are made in the capsule. (3) Removing the calculi with a scoop. (4) After removal of the stones, the cavities in the prostate are packed with gauze. (5) The skin is closed with mattress sutures, the gauze being brought out on the right side. (From "Clinical Urology" by Lowsley and Kirwin. Courtesy of The Williams & Wilkins Company.)

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regarded as especially applicable to younger men. However, it has the disadvantage that calculi are often left behind in the prostate (as has been repeatedly demonstrated by postoperative roentgenograms), so that relief is only temporary.

In older men, who have neared the end of active sexual life, we prefer to treat prostatic calculosis by total prostatectomy both when there is associated benign hypertrophy and when there is no hypertrophy but chronic infection and fibrosis are present. In concomitant calculosis and hypertrophy the concretions will be found embedded between the hypertrophied area and the capsule, having been pushed toward the latter by the developing adenoma. In cases without hypertrophy but with concomitant fibrosis and chronic infection, the inflammatory tissues extend to and through the prostatic capsule, making a clean separation between the infected prostatic tissue and the capsule impossible. It has been found that prostatotomy, transurethral resection, and even the usual conservative perineal or suprapubic prostatectomy often leave enough calculi or infected prostatic tissue to cause persistence or recurrence of symptoms. Removal of the prostate and its capsule is therefore advisable in men whose sexual life is no longer important.

TOTAL PERINEAL PROSTATECTOMY

Indications. Total perineal prostatectomy is an operation which should be done more often than is the present practice. In the past it has been utilized almost exclusively in early cases of prostatic carcinoma, when, as a rule, the seminal vesicles have been removed with the prostate and its capsule. Although early malignancy of the prostate is particularly suitable for total prostatectomy, there are certain other pathological conditions in which removal of the gland with its capsule is definitely superior to more conservative procedures, such as resection, prostatotomy, and the ordinary perineal or suprapubic prostatectomy. These include chronic pyemia and chronic fibrosis of the prostate, two conditions which sometimes fail to respond to any form of palliative treatment; chronic tuberculosis of the prostate with calcium deposits; and prostatic calculosis in men who have neared the end of sexual life, in whom the possibility of the gland acting as a focus of infection makes its removal desirable (see Operative Treatment of Prostatic Calculus).

In certain cases of adenomatous hypertrophy, in which the patient has ceased to have sexual intercourse, it is advisable to do a total prostatectomy in order to minimize the danger of a subsequent development of malignancy. Carcinoma following prostatectomy by the perineal, suprapubic, or transurethral method is not uncommon. Mention has already been made of the frequency with which primary prostatic carcinoma develops in the posterior lobe. No conservative prostatectomy removes the posterior-lobe tubules with the hypertrophied elements because, as

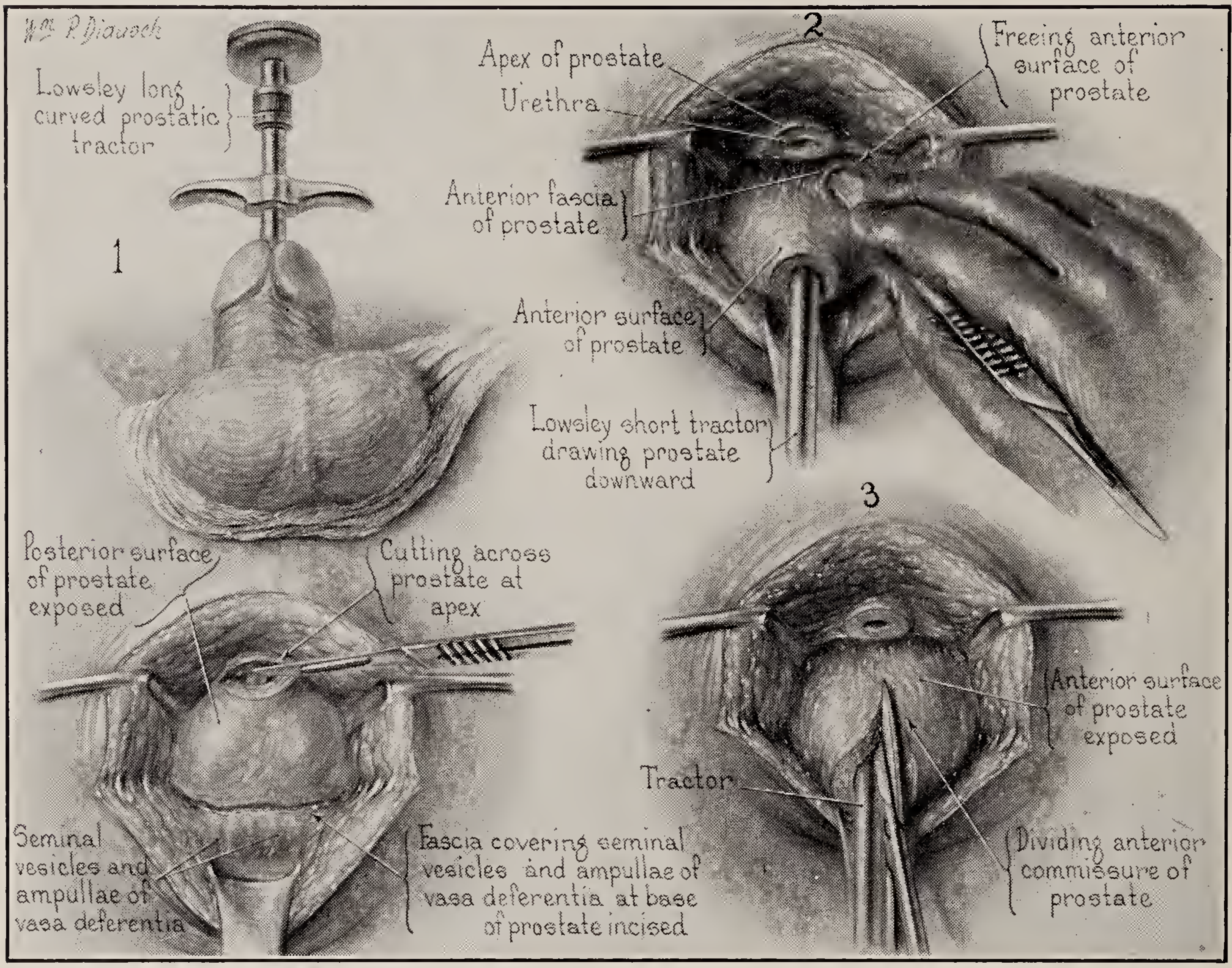
Lowsley long curved prostatic tractor
1
Apex of prostate
Urethra
2
Freeing anterior surface of prostate
Anterior fascia of prostate
Anterior surface of prostate
Lowsley short tractor drawing prostate downward
3
Posterior surface of prostate exposed
Cutting across prostate at apex
Anterior surface of prostate exposed
Tractor
Seminal vesicles and ampullae of vasa deferentia
Fascia covering seminal vesicles and ampullae of vasa deferentia at base of prostate incised
Dividing anterior commissure of prostate

Fig. 72. Total perineal prostatectomy, with removal of seminal vesicles; Kilgore modification of Lowsley technic. (1) The posterior surface of the prostate has been exposed and a transverse incision made in the fascia covering the seminal vesicles. The prostate is being cut across at the apex. (2) The curved tractor has been removed and the Lowsley short, straight tractor inserted and depressed downward, exposing the anterior commissure. The anterior surface is being freed by blunt dissection. (3) Dividing the anterior commissure in the midline (after the manner suggested by Dr. Robert N. Kilgore), exposing the prostatic urethra and vesical orifice. (Courtesy of Journal of Urology.)

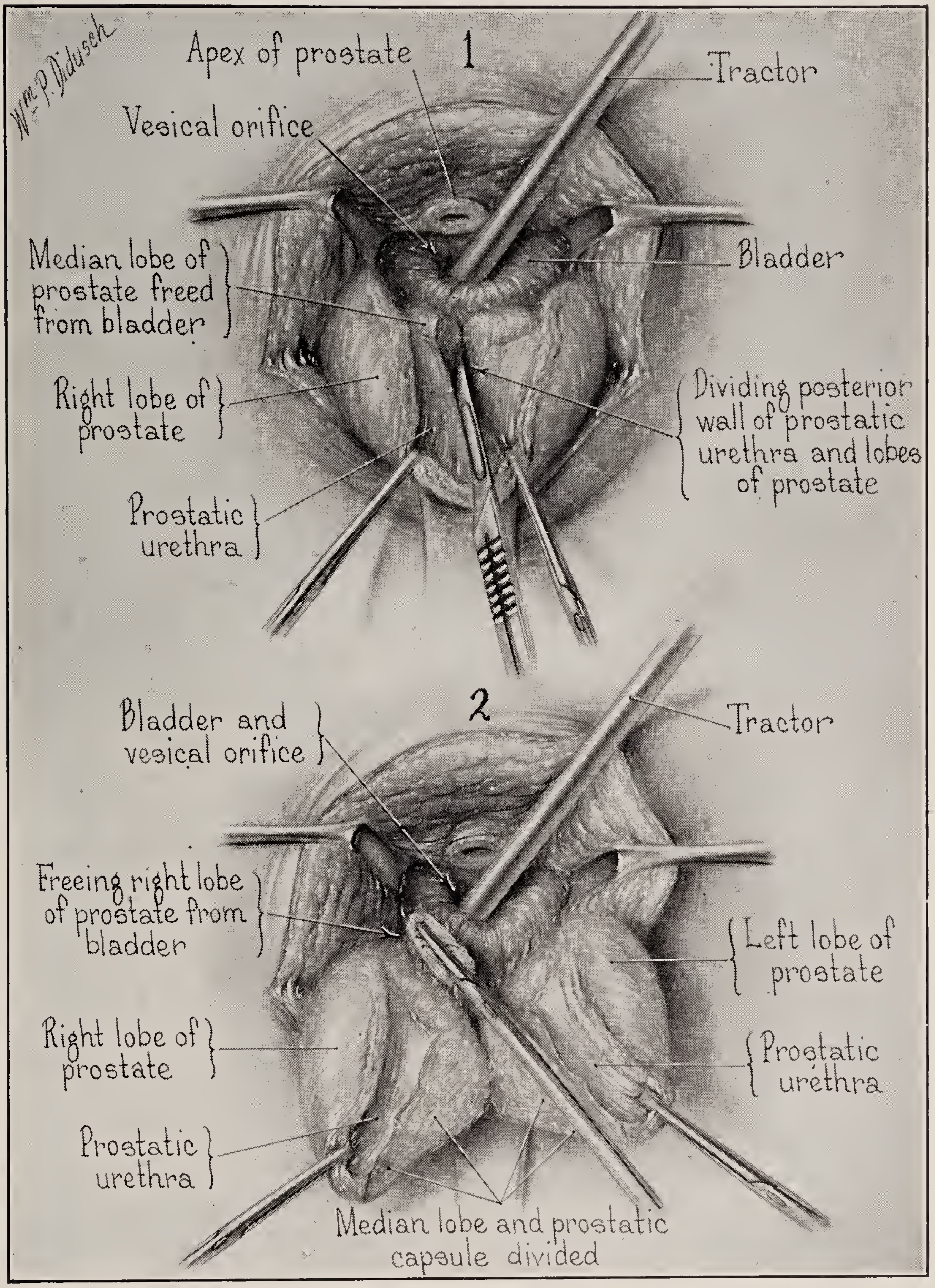
Wm. P. Didusch
1
Apex of prostate
Tractor
Vesical orifice
Median lobe of prostate freed from bladder
Bladder
Right lobe of prostate
Dividing posterior wall of prostatic urethra and lobes of prostate
Prostatic urethra
2
Bladder and vesical orifice
Tractor
Freeing right lobe of prostate from bladder
Left lobe of prostate
Right lobe of prostate
Prostatic urethra
Prostatic urethra
Median lobe and prostatic capsule divided

FIG. 73. Total perineal prostatectomy. (1) A midline incision is made in the posterior wall of the prostatic urethra, dividing the median and posterior lobes of the prostate. This bisects the entire gland up to the vesical orifice. (2) By exerting lateral pressure on each half, the prostate may now be freed from the floor of the vesical orifice without injury to the vesical sphincter. (Courtesy of Journal of Urology.)

our own studies have shown, these tubules do not partake in adenomatous hypertrophy but are compressed by such tumefaction so that, from a surgical standpoint, they become a part of the prostatic capsule. The glandular elements may be distinguished microscopically but not macroscopically. Therefore, in elderly men it seems important to do a total prostatectomy unless it is specifically contraindicated.

Except in the case of cancer, total prostatectomy must not be performed on men who are still active sexually without consultation with the patient, since the seminal vesicles and ampullæ of the vasa deferentia are cut across and ejaculation is therefore impossible.

When total prostatectomy is done for early cancer of the prostate, the seminal vesicles and part of the ampullæ of the vasa also are removed.

Author's method of performing total perineal prostatectomy. The patient is placed on the table in an exaggerated lithotomy position, and a Lowsley curved prostatic tractor is passed into the bladder through the urethra and its blades opened. The usual crescentic incision is made in the perineum, about 1 inch above the anus, and deepened through the subcutaneous tissue until the central tendon is exposed. The fossa on each side of the central structures is opened by blunt dissection. The central tendon is then incised behind the transversus perinei muscles, which are retracted forward.

At this point a Kocher clamp is placed on the subcutaneous tissue and held in the left hand for the purpose of traction. The gloved index finger of the left hand is inserted into the rectum as a safeguard, and the hand is covered with a towel. By blunt dissection the apex of the prostate is discovered; the recto-urethralis muscle either incised or retracted laterally; and the posterior surface of the prostate exposed by separating the fibers of the levator ani muscle, this separation being continued back behind the seminal vesicles. The finger is removed from the rectum, the glove changed, and a piece of gauze placed over the exposed anterior surface of the rectum.

A posterior tractor is then placed in position, and the prostate is cut across at its apex. The curved prostatic tractor is removed, and the Lowsley short straight tractor is passed through the prostatic urethra into the bladder and opened. When the tractor is depressed downward, the anterior commissure is exposed. The

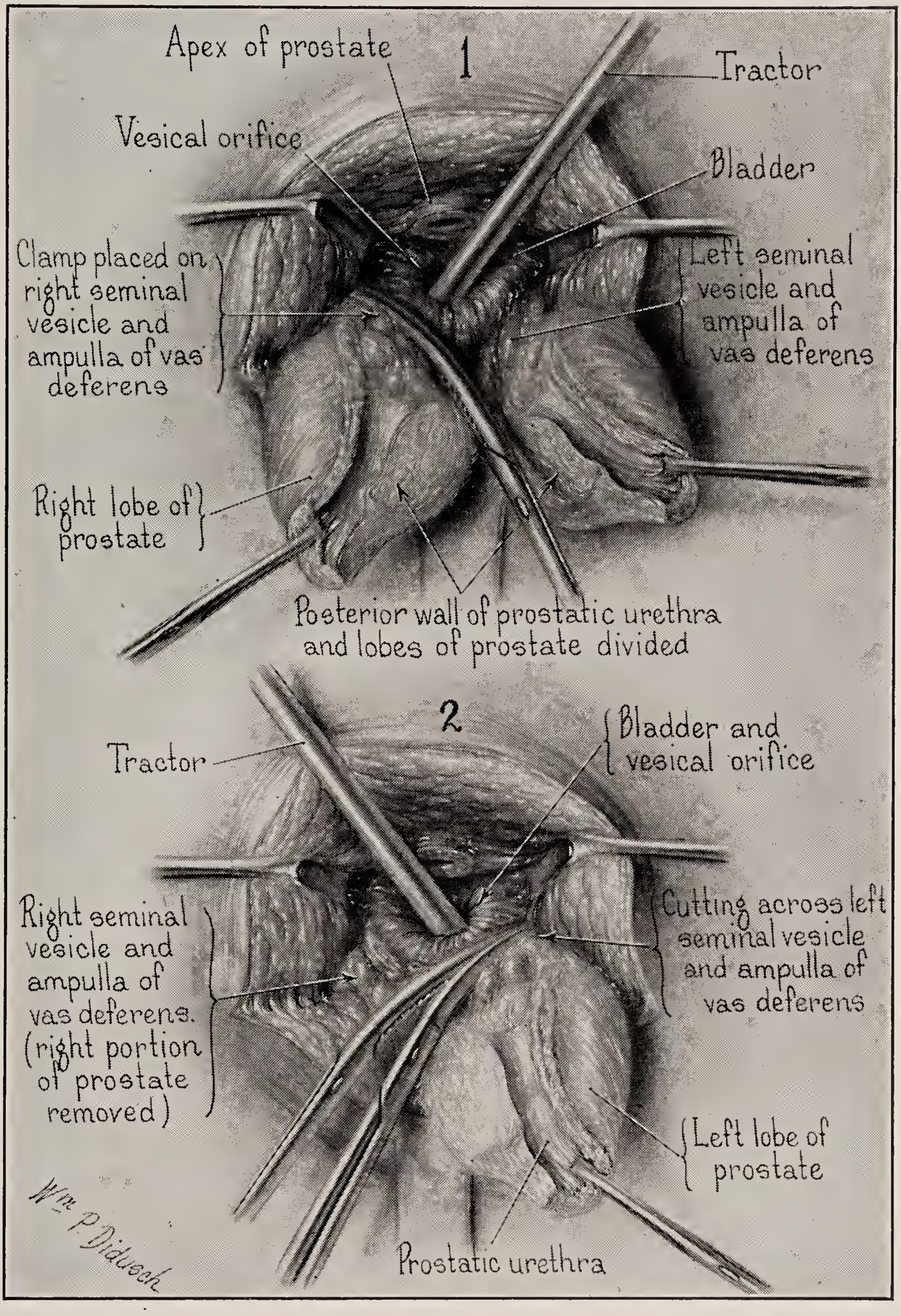
1
Apex of prostate
Tractor
Vesical orifice
Bladder
Clamp placed on right seminal vesicle and ampulla of vas deferens
Left seminal vesicle and ampulla of vas deferens
Right lobe of prostate
Posterior wall of prostatic urethra and lobes of prostate divided
2
Tractor
Bladder and vesical orifice
Right seminal vesicle and ampulla of vas deferens. (right portion of prostate removed)
Cutting across left seminal vesicle and ampulla of vas deferens
Left lobe of prostate
Prostatic urethra
Wm P. Didusch

FIG. 74. Total perineal prostatectomy. (1) A clamp is placed across the right seminal vesicle and ampulla of the vas deferens. (2) The right lateral lobe of the prostate and part of the median lobe have been removed. A clamp has been placed across the left seminal vesicle and ampulla of the vas, and the left half of the prostate is being removed. (Courtesy of Journal of Urology.)

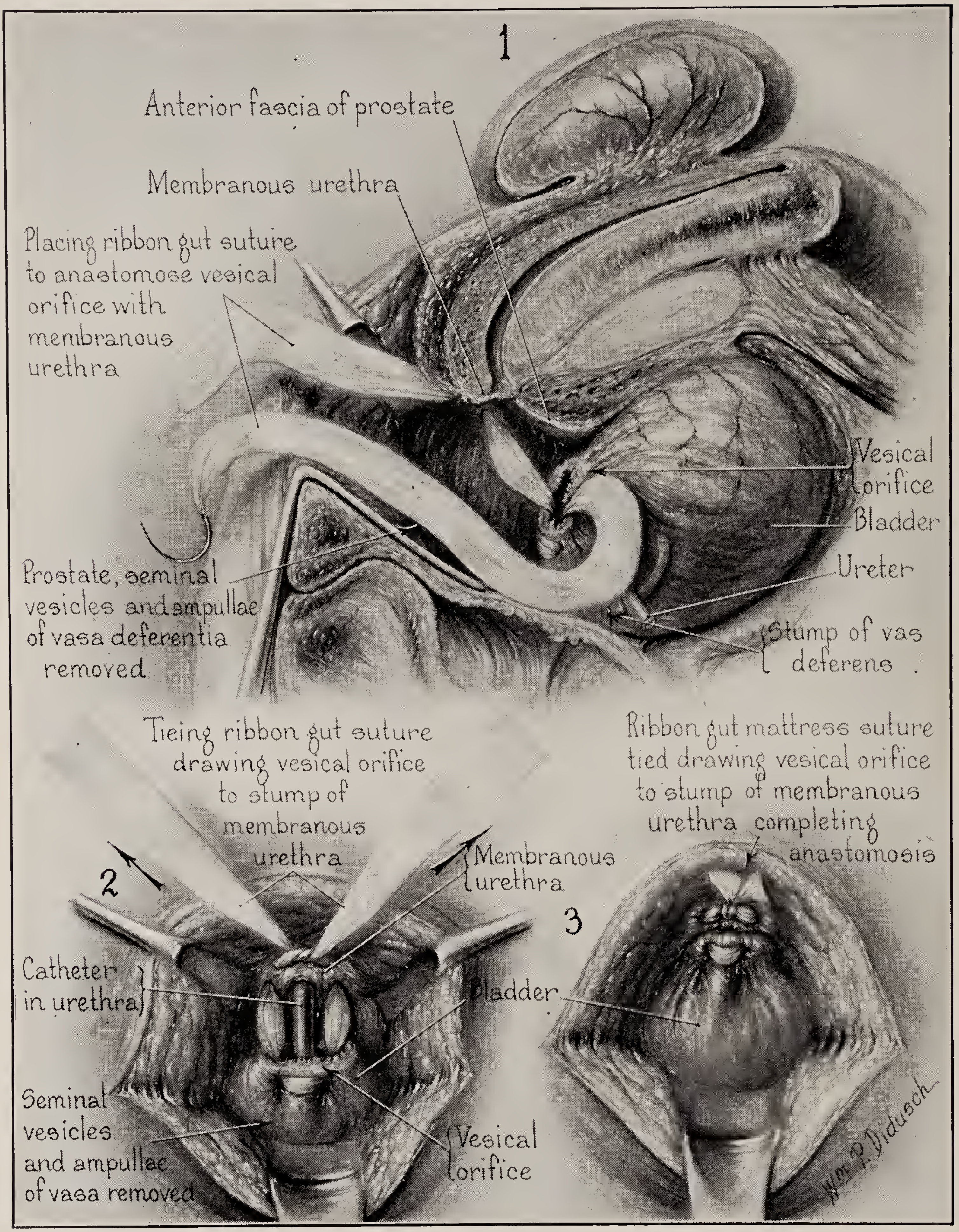
1
Anterior fascia of prostate
Membranous urethra
Placing ribbon gut suture to anastomose vesical orifice with membranous urethra
Vesical orifice
Bladder
Ureter
Prostate, seminal vesicles and ampullae of vasa deferentia removed
Stump of vas deferens
Tieing ribbon gut suture drawing vesical orifice to stump of membranous urethra
Ribbon gut mattress suture tied drawing vesical orifice to stump of membranous urethra completing anastomosis
2
Membranous urethra
3
Catheter in urethra
Bladder
Seminal vesicles and ampullae of vasa removed
Vesical orifice
Wm. P. Didusch

Fig. 75. Total perineal prostatectomy; repair of vesical orifice and urethra with chromic ribbon gut. (1) Sagittal view showing method of placing the ribbon-gut suture to anastomose the vesical orifice with the membranous urethra (see text). (2) Tying the suture to complete the anastomosis. A Foley catheter has been inserted through the urethra into the bladder. (3) Showing the ribbon-gut suture tied, the anastomosis completed, and the urinary canal re-established. (Courtesy of Journal of Urology.)

anterior surface of the prostate is carefully separated from the overlying tissue by blunt dissection, taking great care not to injure the rich venous plexus of Santorini lying just above it, which would result in considerably more bleeding. The lateral surfaces are next separated from the surrounding structures by blunt dissection.

After the prostate has been mobilized down to the wall of the bladder, the anterior commissure is divided in the midline after the manner suggested by Kilgore (Fig. 72), exposing the vesical orifice and the prostatic urethra. A midline incision is then made in the floor of the prostatic urethra, dividing the median and posterior lobes of the prostate and thus bisecting the entire gland up to the vesical orifice.

The prostate is now carefully separated from the neck of the bladder. As the dissection proceeds downward, a group of vessels will be found entering the gland from each of its lateral aspects; these are tied off and cut, thus preventing the excessive hemorrhage which results when this ligature is not placed on each side.

If the seminal vesicles are to be removed (as in early malignancy of the gland), the right vesicle is now exposed by cutting through the three-layered fascia which covers its posterior surface (and which was described by the author in 1912.) This makes the removal of the vesicle relatively easy. The ampulla of the vas on this side is clamped and ligated, and the entire right side of the prostate (containing part of the anterior lobe, the right lateral lobe, and part of the posterior lobe), the right seminal vesicle, and part of the ampulla of the vas are removed in one mass. A similar procedure is followed on the left side.

A Foley catheter is then passed through the urethra and into the bladder.

The cut end of the membranous urethra and the bladder neck are now separated by a considerable space which formerly was occupied by the prostate gland. These two structures are approximated as follows: A suture of three-weeks' chromic ribbon gut is inserted into the left lateral wall of the urethra, then through the anterior lip of the bladder orifice on the left side, and through the posterior lip of the bladder orifice. It is then carried across the apex of the trigonum vesicæ and inserted into the posterior lip of the bladder orifice on the right side, the anterior lip of the bladder orifice, and through the right lateral wall of the urethra. The bladder is drawn to the urethra, which is fixed with an Allis clamp, and the ribbon-gut suture is tied, thus plicating the bladder orifice and the urethral orifice and approximating the two — all with one suture. Another ribbon-gut suture is implanted into the left wall of the urethra, carried over the apex of the trigonum, and then through the right wall of the urethra, and is then tied — thus reinforcing the first suture and making postoperative incontinence rare in this operation.

The Foley catheter is fixed in position by injecting the retaining bag, and the bladder is irrigated. A few clots may be expressed, but there will be no active bleeding because bleeding points can be readily clamped if bleeding has not been stopped by the above-mentioned measures. As a matter of fact, the mattress suture first taken to approximate the bladder orifice and the membranous urethra usually stops all bleeding in this area if the lateral blood supply has been tied off. If not, any bleeding points may be clamped and tied, as is done in open surgery everywhere.

A small piece of vaseline gauze is placed against the rectal wall, and the wound is closed by approximating the levator ani muscles with one or two sutures of chromic catgut, the subcutaneous tissue with plain catgut, and the skin with interrupted silk or dermal sutures.

Advantages of the above technic are: (1) it minimizes the danger of trauma to the vesical orifice, and affords a very satisfactory exposure of the seminal vesicles and vasa deferentia so that they may be clamped and ligated, or removed if desired; (2) packing or a hemostatic bag is unnecessary as hemostasis is accomplished on the operating table; (3) the wounds heal with a minimum of drainage; (4) the passing of sounds, catheters, etc. is much more easily accomplished than in a conservative perineal or suprapubic prostatectomy as there is no cavity in which the instrument may get lost; (5) control of urination is much better than one sees in the average perineal prostatectomy.

NONOPERATIVE TREATMENT OF THE PROSTATE GLAND

Prostatic massage. Prostatic massage is best carried out with the patient in the knee-elbow position; or he may stand bent over a table or a low-backed chair, with his heels separated and his toes turned slightly inward so as to insure a firm stand.

The technic, as well as the results obtained, vary widely with different operators. We believe that prostatic massage is best accomplished by the operator, with his gloved index finger in the rectum, exerting gentle but firm pressure with the end phalanx of the finger upon the lobes palpable from that position, using a downward stroking motion with the force directed toward the urethra. The object is to empty the prostatic acini of their purulent contents and to break up adhesions about the gland. The degree of pressure is a matter of experience and judgment, and is governed largely by the degree of inflammation present. The massage must be firm enough to express the infected secretion. It is continued until the entire portion of the prostate palpable from the rectum has been covered. Secretions later may be expressed from the ejaculatory ducts and the sinus pocularis by bringing the firmly pressing finger downward along the posterior urethra.

The bimanual method, the operator's other hand exerting counter-pressure above the symphysis, is considered more effectual by some operators, especially when it is desired to strip the seminal vesicles as well.

Massage of the prostate is contraindicated in acute infections of the gland. Most cases of chronic prostatitis, however, are benefited by properly applied massage. The treatments are usually carried out twice a week at first. As the patient's condition improves, the interval between the treatments is gradually extended so that he receives massage once a week, then every 10 days, semimonthly, and, finally, once a month.

Application of heat to the prostate. Raising the temperature of the prostate is definitely beneficial in both acute and chronic inflammations of the gland. There are many methods of applying heat to this region. In acute prostatitis, hot rectal irrigations two or three times a day will usually bring relief of the irritation and swelling in a few days, or even sooner. Hot sitz baths, or hot tub baths, of 15 to 20 minutes' duration, night and morning, are also soothing to the inflamed gland. Diathermy is helpful in many prostatic conditions. The greatest elevation of temperature is obtained with the use of a water-cooled orificial electrode. Heat may be applied to the prostate and vesical orifice under direct vision by means of instruments such as the cysto-urethroscope devised by the author. Dry heat, at any desired temperature and pressure, may be applied directly to the prostate and adjacent structures by means of the Elliott Treatment Regulator, which is introduced through the rectum.

Quartz light therapy: intravesical irradiation. Therapy with ultra-violet rays from a quartz light mercury arc lamp is an important part of the treatment of postoperative and inoperable tuberculosis of the genito-urinary tract, including prostatic tuberculosis, which usually is part of a generalized genital, or urogenital, infection. The local application of quartz light therapy has also been found beneficial in nontuberculous infections of the prostate, both for its antiseptic and its tonic effects. The heat, as well as the light, of the lamps is utilized.

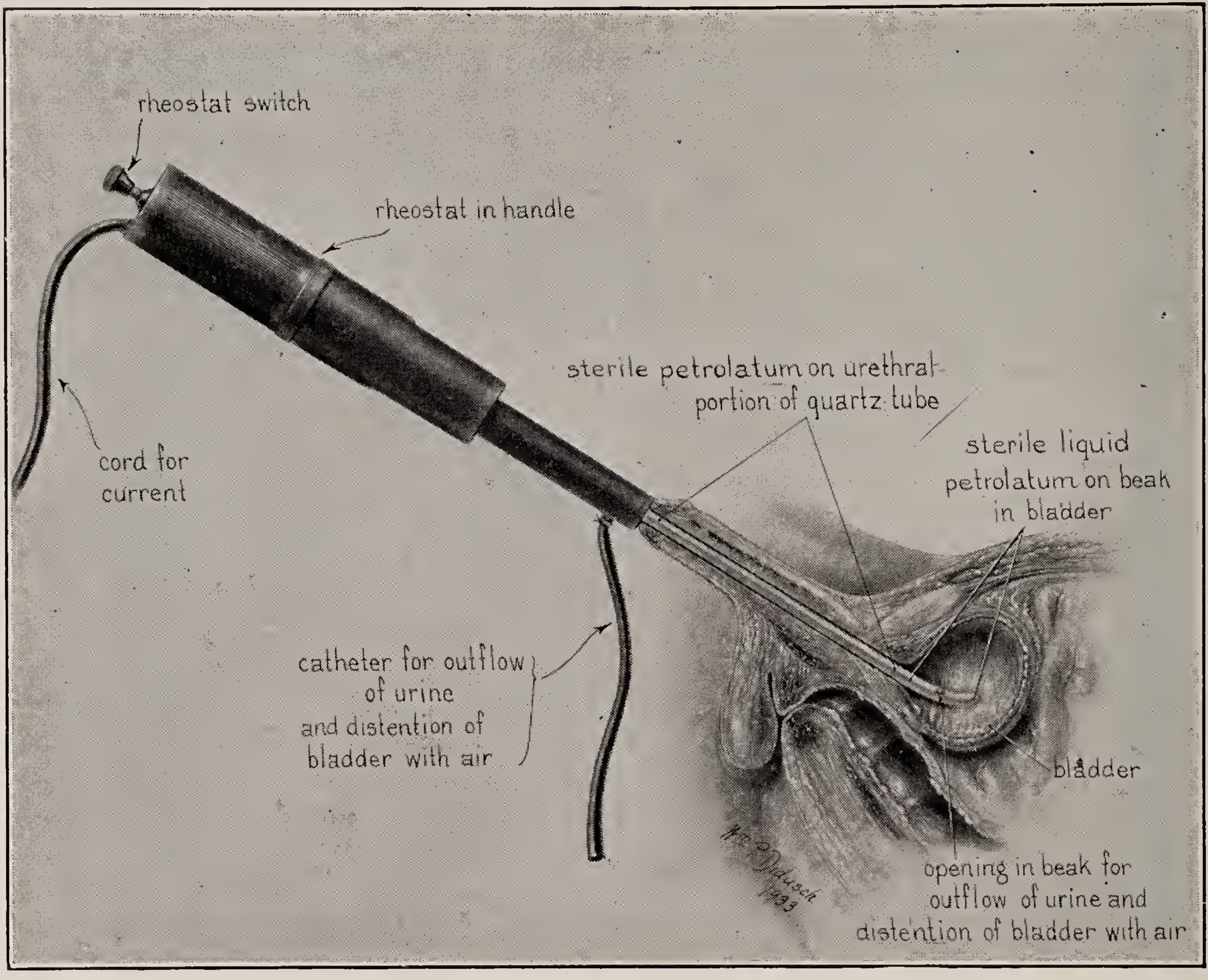
rheostat switch
rheostat in handle
cord for current
sterile petrolatum on urethral portion of quartz tube
sterile liquid petrolatum on beak in bladder
catheter for outflow of urine and distention of bladder with air
bladder
opening in beak for outflow of urine and distention of bladder with air
Wm P Didusch 1933

Fig. 76. Lowsley-Wang instrument for intravesical irradiation. Sagittal view of the bladder and urethra, with the instrument in place and the bladder distended with air for the dissemination of irradiation in the diseased viscus. (Courtesy of Archives of Surgery.)

Local irradiation from the air-cooled lamp is almost a specific in the treatment of wounds and sinuses following nephrectomy and epididymectomy for tuberculosis. In the author's clinic such treatments are given twice every week, beginning with a one-minute exposure at a distance of 20 inches from the wound and gradually increasing to 7 minutes at a distance of 15 inches, continuing thus until healing ensues. Similar exposures are given twice each week — sometimes for long periods — over the regions of the kidney, bladder, epididymis, or testicle in all postoperative and inoperable cases presenting tuberculosis of these organs.

Intravesical irradiation, by means of the instrument devised by Dr. Stanley L. Wang and the author, has proved beneficial in many cases with bladder or prostatic involvement. The irradiations are given once each week, the exposures varying from 5 to 20 seconds, depending on the local reaction. Longer periods and more frequent treatments are unsatisfactory.

The Lowsley-Wang lamp, which can also be used to treat deep, narrow tuberculous sinuses, is of the high voltage discharge mercury vapor type, and operates at a temperature sufficiently low that the heat of the electrode is barely felt on the skin or mucosa. The rays from the lamp differ from those of the usual air-cooled mercury vapor quartz lamp in that they are of a monochromatic nature, since about 90 per cent. are concentrated in the wave length of 2,537 Angstrom units. The intravesical applicator is of fused quartz, and is about the same length and shape as a Brown-Buerger cystoscope and approximately No. 24-French in diameter. There is an extra tube built into the quartz, with an opening near the tip of the applicator and an extension at the other end for the attachment of a rubber catheterizing tube. After the bladder is emptied of urine, air is insufflated through the tube with a syringe to distend the bladder slightly before irradiation. Following the treatment, an instillation can be made through the tube, if desired. The applicator, with the exception of the portion at the distal end, that protrudes into the bladder, is painted with a dark cellulose-base stain which screens the rays from the urethra. The stain is easily removed with amyl acetate when urethral irradiation is desired, and can be reapplied when needed. This instrument offers a simple means of irradiating the interior of the bladder as the viscus can be emptied, distended with air, and irradiated at one operation and with little discomfort to the patient. The applicator passes easily through the urethra, a small amount of liquid petrolatum (which permits the passage of the rays) being applied to its tip for lubrication. The instrument is sterilized in the formalin cabinet, and, when several patients are to be treated, is sterilized between applications by immersion of the applicator in oxycyanide of mercury solution, 1:1,000 for 10 minutes.

Urethroscopic examination in prostatic conditions. A frequent accompaniment of both acute and chronic prostatitis is verumontanitis. This condition is accompanied by a considerable amount of sexual disturbance. The verumontanum is the sexual trigger, and when it is inflamed the patient will frequently suffer from night emissions, premature ejaculations, and various other sexual disturbances. Therefore, when a patient complains of such distressing symptoms, urethroscopy is indicated. The marked inflammatory changes not infrequently revealed by such an examination may be

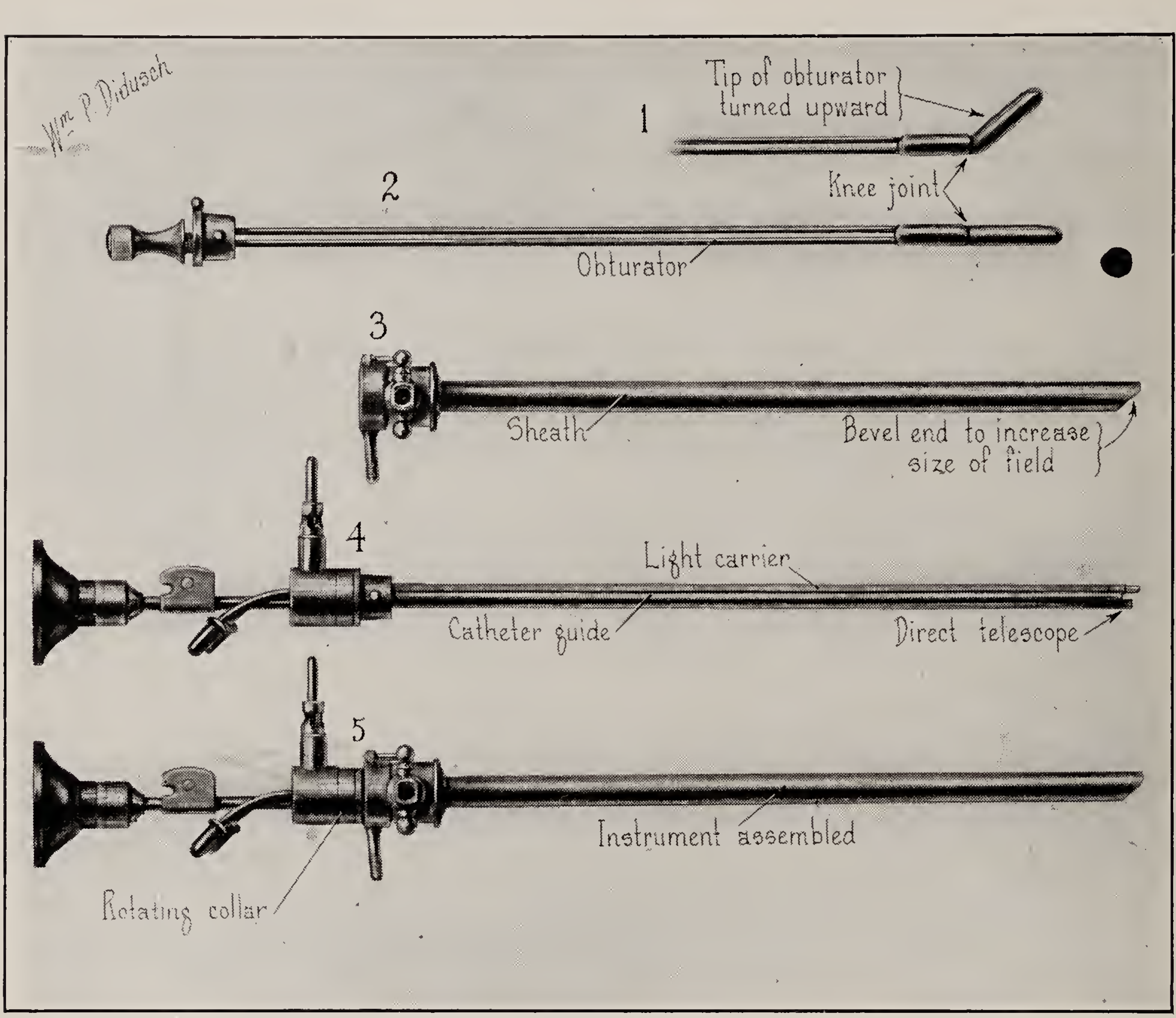

FIG. 77. Lowsley-Peterson Universal Urethroscope. The obturator is placed in the sheath and its tip is deflected by turning the knurled knob of the handle. The instrument is passed into the bladder and inverted as one would pass a concave cystoscope for examination of the trigone. The obturator is then straightened and withdrawn, and light and water connections are made. The sheath should be permitted to fill with water before the telescope is inserted. (Courtesy of American Journal of Surgery.)

the only clue to a low-grade infection of the prostate gland and seminal vesicles. Although no case of chronic prostatitis should be considered properly examined unless urethroscopy has been carried out, it is often wise to delay this procedure until the most acute and distressing symptoms have been allayed by treatment.

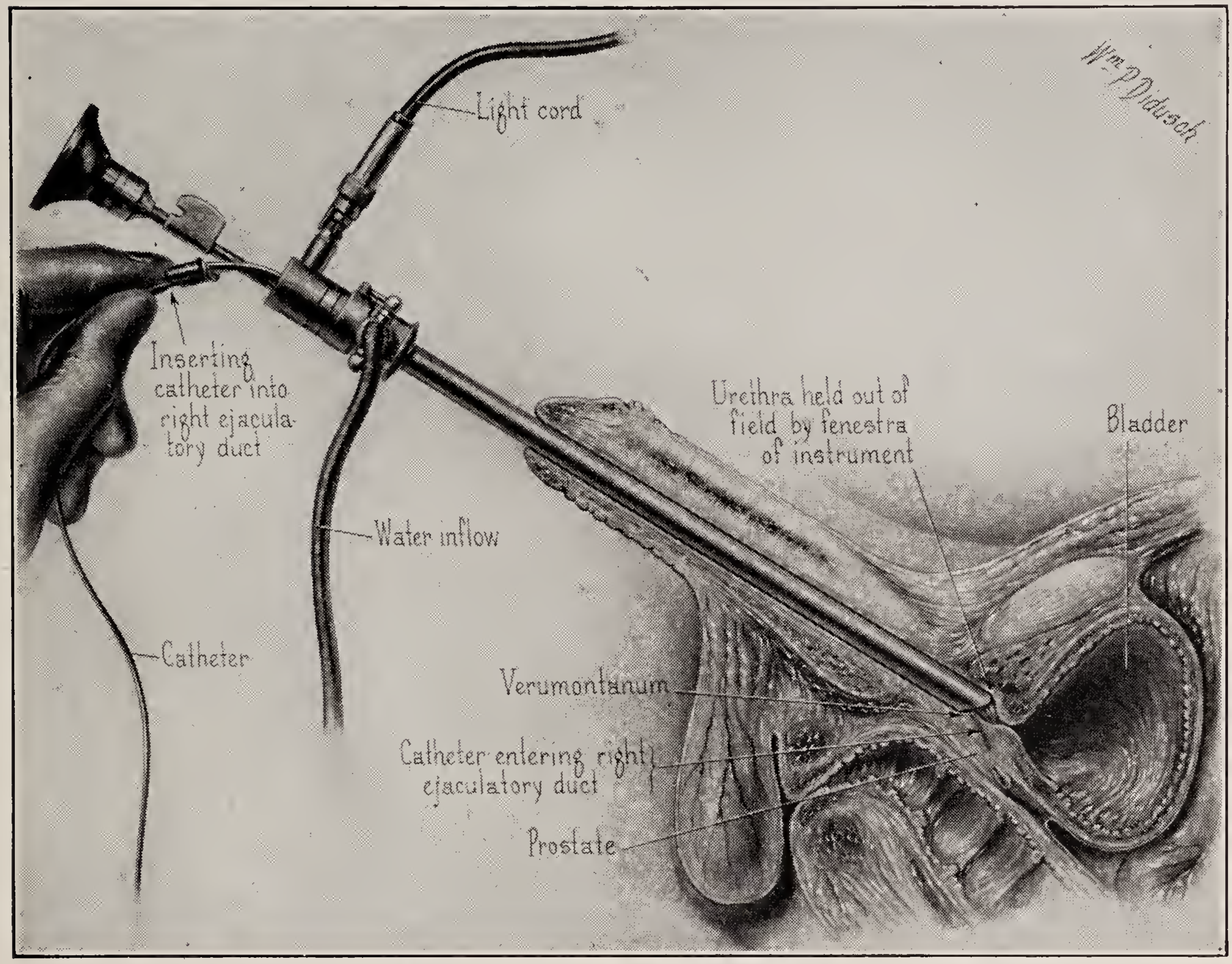
Light cord
Wm P Didusch
Inserting catheter into right ejaculatory duct
Urethra held out of field by fenestra of instrument
Bladder
Water inflow
Catheter
Verumontanum
Catheter entering right ejaculatory duct
Prostate

Fig. 78. Lowsley-Peterson Universal Urethroscope. Catheterization of ejaculatory ducts located on the top of the verumontanum. The ocular end of the urethroscope is raised until the bevel of the fenestra is flush with the floor of the posterior urethra and one appears to be looking down on the verumontanum. Rotation of the telescopic unit will bring the posterior aspect of the verumontanum, the two sides, and its front into the field of vision, as desired. Retraction of the telescope permits observation of the entire verumontanum and insertion and passage of the catheter with unusual facility. (Courtesy of American Journal of Surgery.)

The Lowsley-Peterson Universal Urethroscope is especially designed for the examination and treatment of the posterior urethra, including catheterization of the ejaculatory ducts. The urethroscope is of No. 24-French caliber, round, and slightly longer than the usual instrument. The obturator is of the deflectible beak type, the position of the beak being controlled by the knurled knob on the handle. The sheath is beveled at its distal end to increase the size of the field and provide a canopy for the verumontanum. It is supplied with a water cock for the purpose of introducing water for distention. The telescope is of the direct-vision type and adjustable in position. Two tubular guides, of

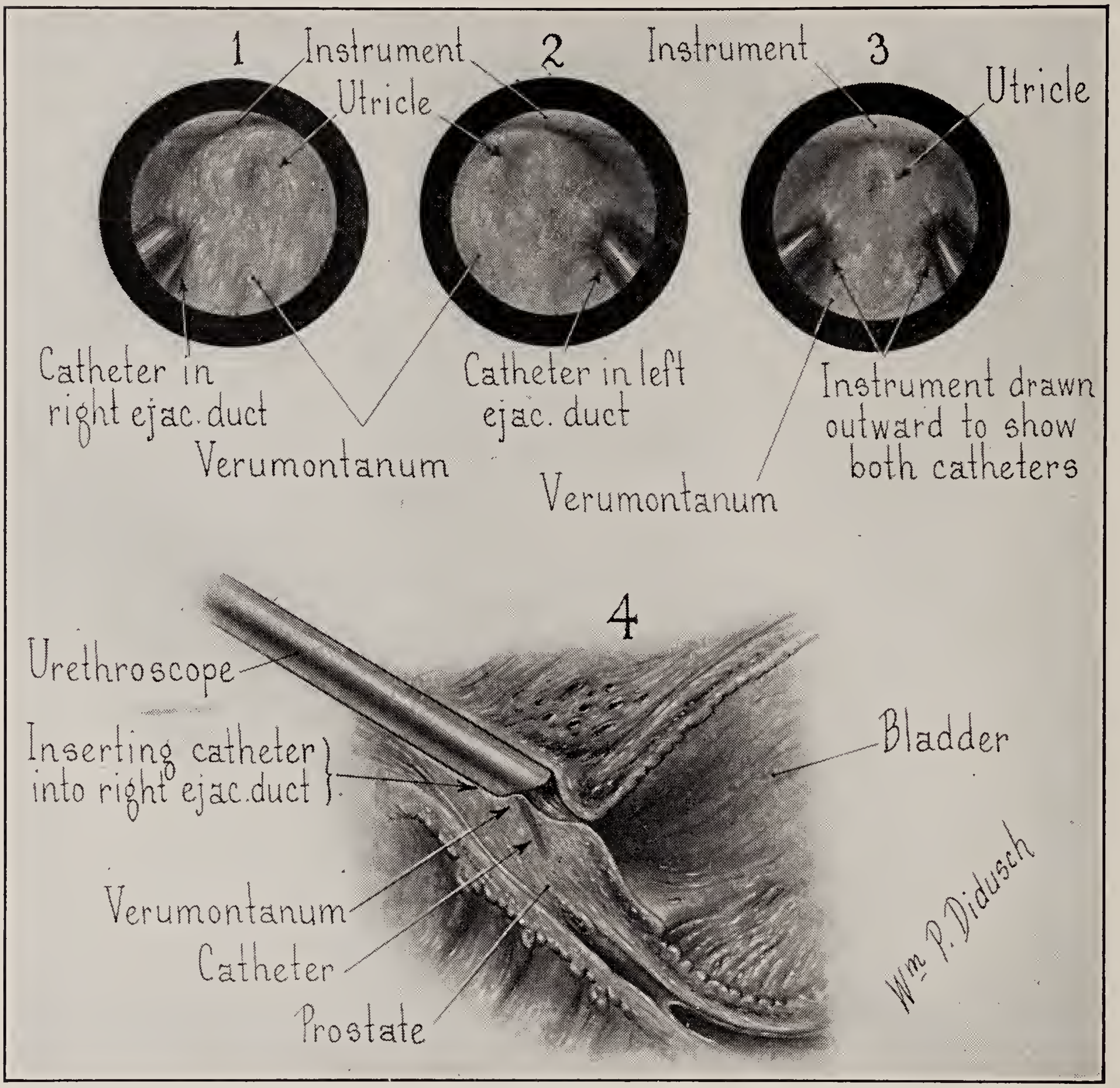
1
Instrument
Utricle
2
Instrument
3
Utricle
Catheter in right ejac. duct
Verumontanum
Catheter in left ejac. duct
Verumontanum
Instrument drawn outward to show both catheters
4
Urethroscope
Inserting catheter into right ejac. duct
Verumontanum
Catheter
Prostate
Bladder
Wm P. Didusch

FIG. 79. Lowsley-Peterson Universal Urethroscope. Catheterization of ducts located on the frontal aspect of the verumontanum. The telescope is loosened and retracted until the light bulb and guides become visible. The catheter is then fed in until it nears the verumontanum. Rotation of the telescopic unit will give the proper direction to the catheter tip for entering the ejaculatory-duct orifice. Further passage should be made slowly and by short stages until a distance of 3 to 5 cm. has been passed. (Courtesy of American Journal of Surgery.)

No. 5-French capacity, run along the light-carrier, which forms one unit with the telescope — the entire assembly of telescope, light-carrier, and guides being rotatable within the sheath by means of a collar. The external ends of the guides are long and sufficiently curved to keep the catheters away from the examiner's face. The internal ends are shorter than the light-carrier and are not provided with special deflectors, the direction of the catheters being given by the position and pointing of the instrument. Although designed particularly for posterior urethral work, this instrument also is very satisfactory for anterior urethroscopy, the fulguration of polyps on the bladder floor, and for unilateral or bilateral ureteral catheterization and renal pelvic lavage.

Diet. Pathological conditions of the prostate gland are frequently accompanied by marked irritation of the bladder. In such cases, a *restricted diet* is recommended. The following foods are eliminated:

Meat	All meats except one serving daily of lamb, fish, poultry, or bacon
Soup	Meat broths
Vegetable	Asparagus, tomatoes, broccoli, peppers, sauerkraut, watercress
Fruit	Grapes, apricots, berries, cherries, plums, prunes, rhubarb, cranberries
Beverage	Alcohol; excessive amounts of tea and coffee
Miscellaneous	Fried foods, condiments

(SAMPLE OUTLINE)

Morning	Noon	Night
Fruit	Meat	Cream soup
Cereal	Potato	Crackers
Toast	Vegetable	Eggs or cheese dish
Butter	Dessert	Vegetable
Milk	Bread	Salad
Cream	Butter	Dessert
Coffee	Milk	Bread
Sugar		Butter
		Milk

This diet contains approximately 65 grams protein, 90 grams fat, 245 grams carbohydrate (2,100 calories).

A *modified alkaline ash diet* is employed in the author's clinic in the treatment of inoperable and postoperative prostatic and other forms of urogenital tuberculosis. It contains foods in such proportion that an excess of alkaline ash is produced, and excludes foods that are irritating to the diseased genito-urinary tract. It serves as a basis for developing a diet adapted to individual idiosyncrasies, being continued or changed with the *p*H of the urine as a guide. This diet fulfills the normal food requirements with the exception of iron. Due to the elimination of eggs and the restriction of meats, the iron content falls below the normal requirement of .015 grams. Fruits and vegetables high in iron should therefore be included in large amounts. The following foods are included in the diet:

Milk	One quart or more of sweet milk daily
Meat	Three lamb chops or three 1½ ounce servings of lamb a week and three strips of crisp bacon twice a week
Soup	Cream soup only
Fat	Any oil or fat
Cereal	One serving daily of any of the following: cornflakes, cornmeal, farina, puffed rice, puffed wheat
Bread	Three slices daily, dark preferred
Vegetable	At least four servings daily with the exceptions noted below
Fruit	At least four servings daily with the exceptions noted below
Salad	Any kind made of the fruits and vegetables allowed
Dessert	One serving daily of any of the following: ice-cream, ices, gelatin, junket; vanilla, chocolate, coffee, caramel, or fruit flavors allowed on the fruit list
Sugar	Any kind
Beverage	With each meal include one glass of orange or pineapple juice or lemonade (containing juice of one lemon); coffee, one cup daily; cocoa, in moderate amounts
Nuts	Almonds, chestnuts, cocoanut
Miscellaneous	Cornstarch, jam, jelly, and marmalade made from fruits as allowed, molasses, tapioca, salt in moderate amounts

The following foods are omitted from the list:

Milk	Sour milk and cream, buttermilk
Eggs	

Cheese	
Soup	Meat broth and all soups made with meat broth
Vegetable	Corn, lentils, asparagus, broccoli, carrots, peppers, sauerkraut, tomatoes
Fruit	Prunes, plums, cranberries, apricots, berries, cherries, grapes, grapefruit, rhubarb
Beverage	Tea; alcoholic, fermented, and carbonated beverages
Miscellaneous	Condiments, pickles, fried foods

(SAMPLE OUTLINE)

Morning	Noon	Night	8 P. M.
Fruit	Meat	Soup	Milk
Cereal	Potato	Potato	Fruit
Toast	Vegetable	Vegetable	
Butter	Salad	Salad	
Milk	Fruit or dessert	Fruit	
Cream	Bread	Bread	
Fruit juice	Butter	Butter	
Coffee	Milk	Milk	
Sugar	Fruit juice	Fruit juice	

This diet contains approximately 75 grams protein, 85 grams fat, 280 grams carbohydrate (2,200 calories).

Radium and roentgen-ray therapy of prostatic malignancy. *Carcinoma.* Although cures of prostatic carcinoma by irradiation have not been obtained, its value as a palliative measure in cases that are too far advanced for radical operation is recognized by practically all clinicians (see Carcinoma of the Prostate: Treatment, p. 746 (88)). Irradiation, alone or following transurethral resection or conservative prostatectomy for the relief of urinary obstruction, has resulted in relief of pain and prolongation of life in many cases. Surface applications of radium through the rectum, bladder, or urethra, interstitial irradiation applied by the perineal or suprapubic route and utilizing both radon seeds and radon-bearing needles, and deep x-ray therapy are all utilized in the treatment of prostatic carcinoma. Interstitial irradiation of the primary growth is preferable to surface applications through the rectum, bladder, or urethra; and deep x-ray therapy in combination with the radium radiation controls the tumor better than the radium alone. Because most of these tumors are radioresistant and far advanced when treatment is instituted, external irradiation alone (by the 200 kilovolt machine) has not proved sufficient to control them; therefore, if substantial regression is to be hoped for, external irradiation must be supplemented by interstitial treatment.

Suprapubic implantation of radon seeds into the prostate is comparatively easy if one desires to reach the lateral and subtrigonal lobes; but the posterior lobe, which lies entirely below the bladder and is usually involved in the malignancy, presents a different problem. Suprapubic implantation must, therefore, be supplemented by perineal treatment if the irradiation is to be adequate.

The original method of treating the portion of the prostate nearest the rectum — namely by means of radium needles inserted into the gland through the perineum — is still widely used. Although the posterior lobe, periprostatic tissue, and perilymphatic invasion around the seminal vesicles can be thoroughly irradiated by this method, the " blind " procedure has its limitations since the radium needles cannot be accurately placed in the deeper portions of the gland.

We feel that, whenever possible, exposing the prostate through a perineal incision and implanting radon seeds through its capsule is preferable as the entire procedure can then be carried out under full vision. Therefore, in cases with obstruction we either do a conservative perineal prostatectomy and implant radon seeds, using the radon seed introducer designed by Dr. Thomas J. Kirwin; or we perform transurethral resection and implant radon seeds in the posterior lobe by means of the Kirwin instrument, which is inserted through a perineal incision. Another method is to insert the McCarthy panendoscope with the radon seed introducer and place the seeds in the area of resection. (Fig. 80.)

Perineal exposure of the prostate and implantation of removable radium needles is preferred by Young, as well as by Chauvin, in cases that are not amenable to radical surgery.

Deep x-ray (200 kilovolt) is widely employed in the treatment of prostatic carcinoma for the relief of pain and obstructive symptoms, but is generally believed to be less effective than the newer supervoltage roentgen irradiation (550 to 900 kilovolts), which also is extensively utilized in those clinics having suitable apparatus. According to Dr. Roscoe G. Smith, supervoltage radiation is su-

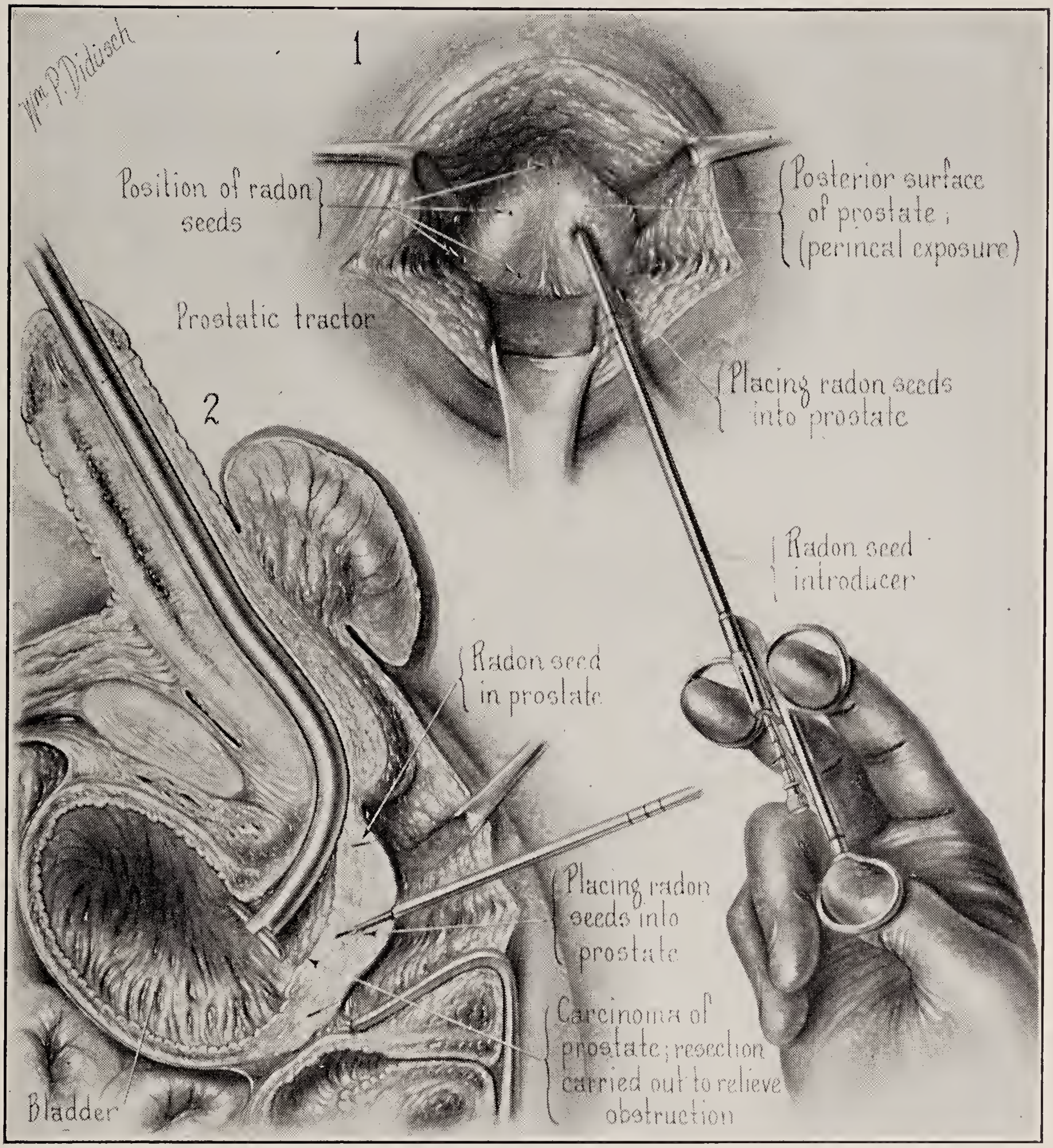
Wm P. Didusch
1
Position of radon seeds
Posterior surface of prostate; (perineal exposure)
Prostatic tractor
Placing radon seeds into prostate
2
Radon seed introducer
Radon seed in prostate
Placing radon seeds into prostate
Carcinoma of prostate; resection carried out to relieve obstruction
Bladder

FIG. 80. Implantation of radon seeds following transurethral resection for carcinoma of the prostate, using the Kirwin radon seed implanter. (1) The implanter is introduced through a perineal incision. (2) Sagittal view showing the conditions present and the position of the seeds after their insertion in the posterior lobe of the prostate. (Another method of using the implanter is to insert the McCarthy panendoscope with the radon implanter and place the seeds in the resected area.) (Courtesy of Journal of Urology.)

perior to 200 kilovolt radiation because (1) the effect of supervoltage radiation on neoplasms closely resembles the changes produced by radium, without the bad effect so often accompanying radium treatment; (2) the blood changes are less severe; (3) radiation sickness and skin erythemas are absent; (4) more rapid tumor regression is noted; and (5) there is rapid relief from pain. While marked benefit in the clinical condition of patients with advanced prostatic carcinoma has been reported by numerous clinicians from the use of supervoltage roentgen irradiation — some patients remaining free from symptoms for periods varying from one to four years — this method of treatment, like other methods of irradiation, can at present only be considered palliative.

High-voltage x-ray is the most effective agent for the relief of pain due to bony metastasis, even small doses giving relief in many cases. Dean states that "the good results probably arise from vascular changes because even in those patients completely relieved, no roentgenographic improvement can be detected."

Sarcoma. The most favorable results in the treatment of prostatic sarcoma have been achieved through the use of radium and deep x-ray therapy (see Treatment of Sarcoma, p. 746 (96)). Although the outcome in these tumors has almost always been rapidly fatal, regardless of the type of treatment used, the superior value of irradiation over the usual surgical procedures has been well demonstrated. Due to the rapid onset and downward course of the disease, surgery, with or without postoperative irradiation, has almost invariably been unsuccessful, whereas radiation therapy has caused prompt regression in many instances, with relief of symptoms and prolongation of life. Almost always the help has been but temporary, but Bumpus and Barringer have each reported a case controlled for 7 years by irradiation. Young has also reported a few encouraging results, and believes that recent progress in radium and roentgen-ray therapy has done away with the need of operations upon prostatic sarcomas. It would seem that unless these growths can be clinically diagnosed at an earlier stage than has been possible in the past — that is, before the malignant process has extended beyond the confines of the prostate, when prostatectomy might prove curative — the only hope of alleviation or cure would appear to depend entirely upon radium or deep x-ray therapy.

At present, the treatment of prostatic sarcoma is directed toward the relief of urinary retention by suprapubic cystostomy and a permanent suprapubic tube, plus treatment of the sarcoma with radium applied alternately through the rectum, urethra, and bladder — deep x-ray therapy being given in combination with the radium. It may be advisable to give deep x-ray therapy to the body to prevent or alleviate metastases. The radioresistancy of these tumors varies considerably. The rare lymphosarcomas are readily affected by irradiation, whereas the rhabdomyosarcomas are very radioresistant.

Stevens and Barringer suggest a modified technic of deep x-ray therapy for these patients similar to that which has been applied to control Wilms tumor of the kidney. The method is designed to control highly malignant, radiosensitive growths developing in organs which have a large and important blood supply — the theory behind the treatment being that " a prolonged external irradiation produces a slow sclerosis of the blood vessels, which is apparently necessary to control the growths." The patient is given 200 r. of deep x-ray daily at 70 cm. distance, using 4 or 5 portals of entry, and continuing for 6 months or more. Retention is dealt with by catheterization, or, if this is impossible, by a semipermanent suprapubic tube.

Roentgen-ray therapy of benign prostatic hyperplasia. Deep x-ray therapy of benign hyperplasia of the prostate gland is not a new idea, but it is only during the last ten years or so that it has received serious consideration. It is now an accepted procedure, but opinions vary as to the effect of such treatment. Subjective benefits — alleviation of the associated edema and congestion, with relief of retention and reduction or abolishment of the residual urine — have been reported by Schiller and Altschul and K. Abel, in Germany, Barringer and his coworkers at the Memorial Hospital (New York), and a number of other urologists and radiotherapists. Others have found it valueless in reducing prostatic enlargement.

The usual practice is to employ a 200 kilovolt machine at 50 cm. distance and give dosages varying from 200 to 300 r. each three times a week until 1,000 to 1,500 r. have been administered, repeating the treatment cycle after an interval of about 6 weeks, if necessary.

R. A. Moore, from a histological study of 12 cases, found only slight changes that might be attributed to roentgen irradiation, such as slight periacinar fibrosis and a relative absence of lymphoid tissue and evidences of inflammation.

The more conservative urologists and radiotherapists incline to the opinion that the only effects of deep x-ray irradiation of the hyperplastic prostate, as at present administered, are a definite alleviation of the associated congestion and edema, giving temporary relief in selected cases. It cannot be regarded as a substitute for prostatectomy or resection; but the benefits thus far derived from its use would seem to warrant further experimentation with this agent.

Medication. When prostatic pain is very severe, sedatives are often necessary. The barbiturates usually suffice, but occasionally it may be necessary to give codeine, pantopon, or morphine.

When there is pain in the region of the prostate gland, or during micturition, the patient should be given a soothing prescription, such as Kirwin's Mixture:

Potassium citrate	Drams VI	(24 cc.)
Tinct. Hyoscyami	Ounce I	(30 cc.)
Tinct. Opii camphorata	Ounce I	(30 cc.)
Elix. Saw palmetto et Santalwood q.s. ad	Ounces IV	(120 cc.)

Sig.: — Drams II (8 cc.) q. 4 hours.

In recent years, with the introduction of the sulfonamide drugs, chemotherapy has assumed an important place in the treatment of chronic prostatitis, and has proved of considerable value in shortening the acute stage of prostatic infections. It has also been found very useful, both preoperatively and postoperatively, in combating infection in patients undergoing transurethral resection. Before the introduction of sulfanilamide, interest was centered chiefly on methenamine and mandelic acid. Both of these drugs were, and still are, of definite value as urinary antiseptics, but their usefulness is limited since they depend for their action on a certain degree of urinary acidity and the necessary concentration of the bactericidal substance in the urine. The sulfonamides have the advantage of being effective in either alkaline or acid urine, provided the concentration is adequate. The patient does not need to change his regular diet or habits, though close observation is necessary, and rest in bed is desirable in many cases since the sulfonamide group of drugs is more toxic than mandelic acid or methenamine.

Of the numerous sulfonamide drugs at present on the market, sulfathiazole and sulfadiazine are the most generally useful in the treatment of prostatic infections, both specific and nonspecific, and, because of their efficacy and greater tolerability, they have largely supplanted sulfanilamide and sulfapyridine. However, sulfanilamide is still the most efficient drug in the treatment of infections due to the *Streptococcus hemolyticus*, which respond well to relatively small doses of this drug. Both sulfathiazole and sulfadiazine are of proved superior value in combating the more common types of infection affecting the prostate gland, such as those due to the gonococcus, *Staphylococcus aureus* and *albus*, *Bacillus coli* (*Escherichia*), and *Bacillus proteus*. Both are effective in all stages of gonorrheal infection, and in patients who have proved refractory to previous sulfonamide therapy. In small doses, they have also proved very useful, both before and after operation, in preventing or combating nonspecific bladder infections in patients undergoing transurethral resection of the prostate.

It is our practice to give fairly small doses of these drugs since clinical experience has shown that the use of larger doses is not followed by a corresponding increase in the therapeutic response. Ordinarily, 2 grams of the drug are given daily in 4 doses (one after each meal and one at bedtime) for from 7 to 10 days. The initial response to treatment is usually rapid. In chronic prostatitis, a second course, of similar dosage and duration, is usually given after a rest of a week or two. Additional short courses, at fairly frequent intervals, may be given when necessary. With conservative doses of sulfathiazole or sulfadiazine, one rarely sees the untoward reactions so commonly observed with the older sulfonamide drugs and frequently seen even with the less toxic newer derivatives when given in large doses. This is particularly important in the case of ambulatory patients, who cannot be closely followed by blood counts. The use of larger doses is not without danger, particularly when there is impaired renal function, and should be undertaken only under strict supervision.

In acute prostatitis with impending abscess, we give larger doses (3 to 4 grams, or even more, daily). In these cases we hospitalize the patient, and examine the urine for crystals and keep a careful check on the blood count.

It should always be remembered that the clinical efficacy of any sulfonamide drug must be carefully weighed against its possible toxic effect. Even in the case of the newer derivatives of relatively low toxicity, the potential harmful effects, and the varied response of individuals, must not be overlooked. Hemoglobin determinations and red and white cell counts should be made frequently whenever a sulfonamide is being given for any length of time or in larger dosages.

Although sulfathiazole and sulfadiazine are considerably less toxic than sulfanilamide, undesirable by-effects do occur from their use in some cases. Such reactions are usually transitory and mild in form, and include headache, nausea, rash, low-grade fever, dizziness, slight cyanosis, and slight acidosis. As a rule, these subside promptly on decrease of the dose or withdrawal of the drug. With low initial and maintenance dosages, these reactions are reduced to a minimum. It must be remembered, however, that sulfathiazole and, to a less extent, sulfadiazine, is capable of producing severe damage to the liver, kidneys, spleen, and hemopoietic system. These serious effects may be largely eliminated by employing small dosages (2 to 3 grams daily), avoiding sunlight, forcing fluids to about 3,000 cm. daily, examining the blood and urine at frequent intervals, and hospitalizing the patient when larger dosages are deemed necessary.

When sulfathiazole is being given, the simultaneous administration of an alkali (such as Kalak water) is advisable in order to decrease the incidence and number of crystals of this drug in the urine.

The administration of the sulfonamides is usually by mouth, but if the patient is unable to take the drug orally, or if an adequate blood concentration cannot be obtained by oral administration alone, the drug may be given intravenously or rectally. In that event, sodium sulfathiazole or sodium sulfadiazine, in a 5 per cent. solution in sterile distilled water, is usually employed.

Recently we have been placing sterile sulfathiazole or sulfadiazine powder in surgically drained prostatic abscesses, with very beneficial results.

For the occasional patient who cannot tolerate the sulfonamides, methenamine may be used. This is a most useful drug for the treatment of colon bacillus and staphylococcic infections, and has been widely employed for over a quarter of a century. It is chemically stable, nontoxic, and inexpensive, and can be given in large quantities without injury. Some patients can tolerate methenamine and remain ambulatory, whereas with sulfanilamide or mandelic acid therapy they are unable to do so. Since methenamine acts only in an acid urine, an acidifying drug is essential. For the treatment to be effective, the methenamine and acid sodium phosphate, or other acidifier, must be given in sufficiently large doses — not less than 4 grams a day, in divided doses.

Many urologists have found mandelic acid very satisfactory for combating colon bacillus infection of the prostate gland, although its use has now been largely superseded by the employment of the sulfonamides. The urine must be kept below a *p*H of 5.5 for full therapeutic response, and fluids should be limited to 1,200 cc. a day. Daily testing of the urine and close observation of the patient are necessary. If administered in the form of ammonium mandelate, a secondary acidifying drug is unnecessary; but when sodium mandelate is used, an acidifying drug, such as acid sodium phosphate, is required. Calcium mandelate, introduced in 1937 by Schnohr, of Denmark, has found considerable favor. This almost tasteless white powder has efficient acidifying properties and contains no sugar, hence is easier to use in the treatment of diabetics. Two grams 3 times a day, for 6 to 8 days, is usually satisfactory. After several weeks of rest, the course may be repeated if necessary.

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THE INTRAURETHRAL TREATMENT OF VESICAL NECK OBSTRUCTION

BY

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HISTORY

Guthrie's " elastic structure." Almost exactly a century has elapsed since obstruction at the vesical neck was first recognized as a clinical entity. The history of the surgery of this particular portion of the urinary tract is really the history of the various instruments which have been designed to give relief to the sufferers from urinary retention and the long train of ills which it entails.

The first mention of vesical neck pathology, as distinguished from hypertrophy of the lobes of the prostate, appears to be that made by Guthrie in his *Anatomy and Diseases of the Urinary and Sexual Organs*, first published in 1832. Herein he states, " An elastic structure exists at the neck of the bladder which may be diseased without necessary connection with the prostate gland." This " elastic structure " was what we have since come to designate as *median bar.*

Mercier's bar. No attention seems to have been paid by Guthrie's contemporaries to this notable step in the progress of urinary surgery. More than twenty years later, when the French surgeons, Civiale and Mercier, fell to quarreling as to priority in the design of instruments employed to relieve bladder neck obstruction, the medical world received their pronouncements as if the idea were entirely original. And, though Guthrie has of late received due credit as the first to recognize and attempt operative relief of obstruction at the bladder neck, the older misconception still persists in the common designation of the condition as *Mercier's bar.*

Guthrie's instrument. In his Lecture XVI, *On the Cure of the Bar at the Neck of the Bladder,* Guthrie informs us: " The silver catheter or the solid sound are not always competent to effect a cure, or even to give relief when passed from time to time . . . The attempt to dilate the neck of the bladder by a larger, or by a dilating instrument only brings on pain and increases the evil . . . In these cases recourse must be had to the permanent catheter . . . which, by its slow and gradual operation, leads to absorption of the bar or stricture . . . When, however, in spite of the continued use of this instrument, the disease increases . . . I . . . would suggest that an operation be performed . . . I recommend its being done by an instrument which Messrs. Everill and Mason, of Saint James's Street, have made at my suggestion, being an improvement on the central perforator or lancet of Mr. Stafford, which renders it capable of cutting on the side and of being easily cleaned. Messrs. Everill and Mason wished to call it my instrument; but as I never claim more in any instrument than the suggestion, leaving the mechanism entirely to the artist, I have begged them to take to themselves any or all the merit which may be due it, or them. The first instrument I used of the kind was made for me by Mr. Ferguson, several years ago; and he made many attempts before he succeeded. Messrs. Everill and Co. have perfected it."

"When the nature of the complaint has been well ascertained by repeated examination in every way, an instrument of the same shape [i. e., as the No. 2 prostatic catheter] carrying at its extremity the small concealed knife alluded to, should be selected, and which, by a spring, is made to project as much by the side, or by the end, or by both, as may be thought advisable. The knife being projected just as the instrument is felt to be passing over the bar, will cut it, and if, after it has just been passed into the bladder, it be withdrawn, the little knife, in coming back, will enlarge the original cut; or it may be made altogether by the withdrawing motion of the instrument, the knife being sprung after it has just entered the bladder. If the bar be thin or narrow, I have no doubt of the possibility of dividing it in this way without doing mischief; and in the two cases in which I have tried it, I have reason to believe the object was effected, from the greater facility with which the catheter afterwards passed into the bladder, and from the relief obtained in passing the urine."

In the third edition of his treatise on the genito-urinary organs, published in 1858, Civiale thus expresses himself in regard to Guthrie's instrument: "For incision of those urethro-vesical barriers, various instruments have been proposed, most of them mechanically ingenious, but shown by experience to be lacking in practical value. I am not speaking of the English instruments; that of Monsieur Stafford, which has been most employed of late, even with Guthrie's modifications, few know how

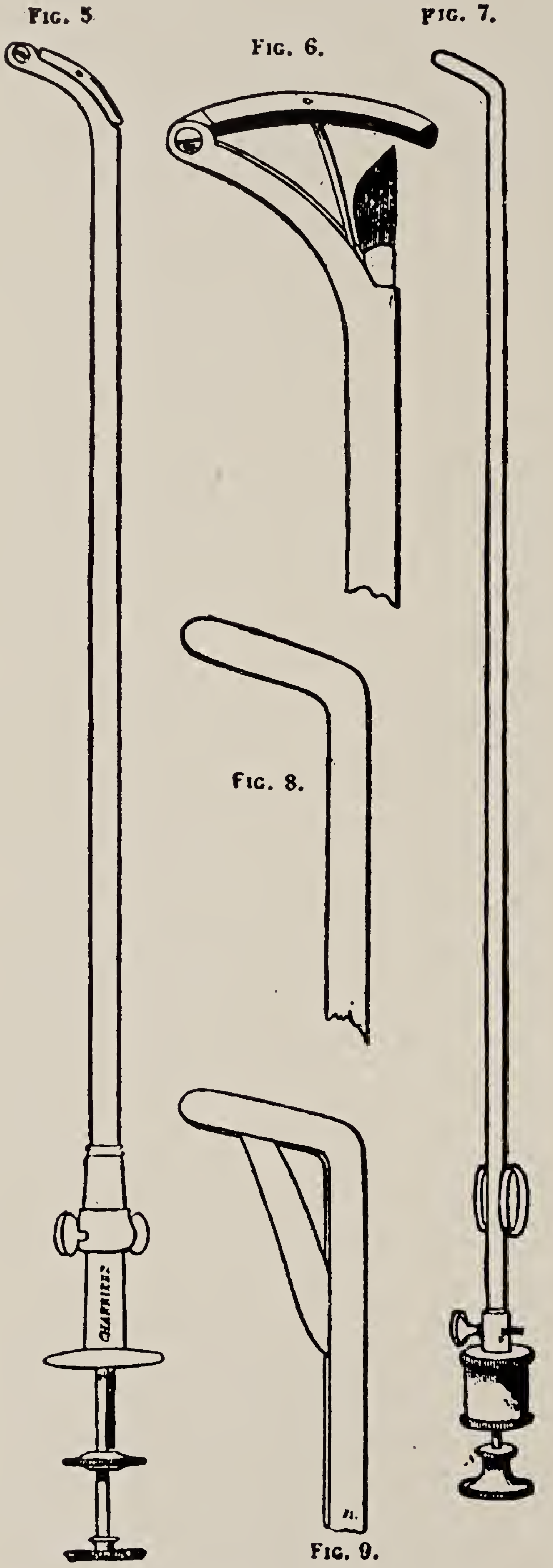

Fig. 1. Civale's Instrument. (From his *Maladies du col de la vessie*, p. 167, Paris, 1858.) Translation of the original legend reads: Fig. 5. — Kiotome, one-half actual size, closed and ready for introduction into the bladder. There are shown the configuration of the instrument, the position of the articulating branch, of the three rondelles, and of the two pressure screws. Fig. 6. — Vesical end of the same instrument, actual size. There can be seen the movable part of the articulating branch, in front, together with the bar which moves it; the triangular space left by this arrangement receives the valve (i.e., the obstructing tissue) before the blade is pushed out. The blade is shown emerging from its sheath, as it does when the operation is in progress. While exploration is being made the blade is sheathed, but is nevertheless open on one side; this side is applied against the anterior surface of the valve (obstruction), at the same time that the movable branch presses on its posterior aspect, so that the barrier is completely embraced and even compressed by the instrument. Fig. 7. — Mercier's instrument, reduced size. Fig. 8. — Extremity of Mercier's instrument, actual size, with its hidden blade. Fig. 9. — The same with its blade extended. These figures also show the *curves* of the elbowed sounds used by this surgeon (i.e., Mercier).

to use without danger. It is useful only in making a chance puncture, for in applying the blade designed to divide the barrier, it must be employed without a guide, cutting from below upward, from in front backward, without any surety that one will reach the tissue that it is desired to sever. To be sure, the blade will only be obtruded from its sheath for a given distance but even so it remains a keen-cutting edge-tool applied quite without guidance. For my own part, I would be afraid to make use of anything fraught with such dangerous possibilities."

Civiale's design. Having thus disposed of Guthrie, Civiale proceeds to describe his own special method of overcoming obstructions at the vesical neck. For this purpose he used an instrument originally intended as a urethrotome. A bead jutting out made the operator aware when the tip reached the obstructing bar where the cutting should begin. The blade worked from behind forward, from the free edge of the bar toward its base. By pushing the blade out as far as desirable from the olive, the cut could be deepened as much as the operator judged wise. Previous to having employed this instrument, Civiale had had one made which resembled an ordinary sound, 6 millimeters in diameter and divided one-third of its length to within 8 millimeters of its vesical extremity. Only one of these divisions formed the smoothly rounded extremity. The other was a trifle shorter and fitted against the side of the longer part, so that when closed the instrument had the shape of a regular sound. Within the tube formed by the closing of these two parts another tube was placed, which extended as far as the middle of the curved portion and had a button, 27 millimeters from its end, which lodged in a groove on the inside surface of the outer tube at the point where it began to curve. The inner tube carried a straight blade 22 millimeters long. When the button was fitted into its niche within the exterior tube, the two blades came together, but when the button was pushed upward 5 to 7 millimeters, the branches divided to 11 to 13 millimeters, permitting the knife blade, which was pushed upward at the same time, to advance from the inner surface of the external tube in front of the button and between the two arms of the instrument.

The technique consisted in fixing the button in its niche so that the two branches came entirely together, concealing the blade and closing up the outer tube, permitting it to be introduced exactly as if it were an ordinary sound. As soon as the convexity of its curve reached the tissue to be resected, its branches were opened by pushing up the internal tube; the button projected far enough from the external tube to indicate exactly where lay the free edge of the median bar. As soon as it was decided where the chief point of obstruction existed, the knife blade was pushed out, the amount of its advance having been decided beforehand by measurement upon a scale. The obstruction was then cut through from behind forward and from its free edge toward its base. This incision was not to be more than two or three lines deep, although several cuts might be made side by side if deemed expedient. " By means of this instrument, division of the obstruction can be accomplished with facility and greater certainty, for by pushing the button, the two blades of the external tube can be separated so that the lateral lips of the vesical neck will be stretched apart and rendered more gaping. After one or two incisions are made, the blade is drawn back into its groove, merely by finger traction; by pushing down the crosspiece of the inner tube, the button which holds the two blades apart is replaced in its niche, and the instrument becomes what it was at first; that is, an ordinary sound with two lateral rings, a crosspiece, two press-buttons and a loop at the extremity."

Mercier's device. Without stopping to evaluate the merits of the controversy which so agitated Mercier and his rivals, we will try to translate accurately Mercier's own description of the instrument which he

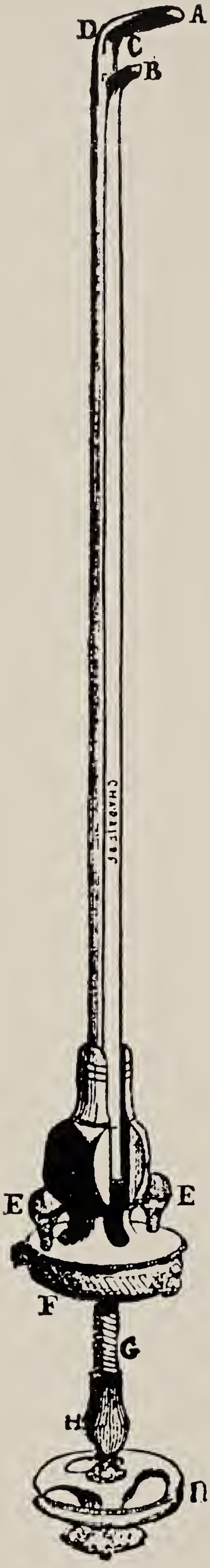

FIG. 2. Mercier's instrument of 1850. (From his *Researches sur le traitement des maladies des organes urinaires*, Paris, 1856.) Text accompanying this figure says: My excisor of 1850 bears a certain resemblance to a two-branched lithotrite, except that the angle which it forms is more acute, so as to be almost a right angle. It is made up of two parts; the male part, BG, and the female part, AE. Near elbow D the female portion is fenestrated so as to afford a sort of mortise hole, C, the edges of which are sharp on the concave side, while those edges which correspond to it on the dorsal surface are made as smooth as possible . . . That the bringing together of the two branches may be accomplished as gently as possible I have furnished the external extremity of the female portion with a thumb screw, F, which may be rotated at will upon a threaded shaft, G, incorporated in the male portion of the instrument. By making a turn or two with rondelle, H, I can bring the two branches together so that one fits into the other without any jarring or halting. . . . As the male part penetrates almost completely into the mortise in the female part, it is impossible for the excision to be imperfect, and the excised piece of tissue falls into the bladder whence it is washed out with the urine, or, if not, can easily be removed with a small calculus extractor.

designed for resection of the vesical neck. "This instrument is composed of two parts; one part resembles the female portion of Heurteloup's *percuteur,* except that it is smaller. Its curved portion, only 8 lines long, is smooth, save near the top of the angle which it forms with the other portion. At this point it is crossed by a groove which is filled with elastic substance to protect its point of contact with the other piece. Its right portion has a transverse groove close to this angle just mentioned. The second, or male portion is a straight shaft slipping inside the first described portion, terminating in a gouge-like piece which is very sharp on its entire curved edge. This serves for cutting the valvular obstruction, which is caught between this blade and the curved part of the female branch when pressure is brought to bear on the blade."

Somewhat later, Mercier designed a slightly different incisor, the conical "gouge" being replaced by a straight blade. Still later he brought out a two-bladed instrument for excising tissue, to which he eventually added a prong or needle which penetrated the tissue to be cut and held it more firmly for incision. The impaled piece of tissue could then be withdrawn along with the instrument. Both of the earlier instruments were used in the same way. The instrument was introduced into the bladder with the blade or gouge sheathed, the shaft was then turned, the blade pushed out by pressure from below, and the instrument slowly withdrawn until the blade came in contact with the obstruction at the vesical neck. Pressure exerted upon the handle of the cutting blade then made an incision in the obstructing mass of tissue. One "bite" with the gouge was usually sufficient, but, if the blade were used, several lateral cuts had to be made, the blade being turned from side to side until a sufficiently wide gutter had been formed.

Bottini's cautery incisor. Medical literature has little to tell us regarding the treatment of vesical neck obstruction for more than twenty years after the attempts at solution of this vexed question which have just been cited. Not until 1874 did Bottini put forward his project for effecting division of the obstructing tissue by means of the galvanocautery. In the interval, the use of anesthesia had become general, so that the possibilities of urologic surgery were infinitely extended. But up to this time, hemorrhage — the greatest drawback to all the procedures advocated by the earlier workers — had been so obstinate and so profuse as to render operation oftentimes impossible.

By means of the galvanocautery Bottini greatly lessened this danger. The Milan instrument-maker, Camposteano, contrived an instrument like a catheter, with a short beak placed almost at a right angle with the main shaft, this beak closely resembling that designed by Mercier. The cautery incisor, resting on a china plate close to the beak, was a platinum blade, 2–2½ cm. in length. There was likewise another Bottini instrument, an ‘ incisor ’ consisting of two parts, male and female. The male arm carried the platinum blade, averaging 1.2 cm. in length, which was extruded from the interior of the female arm by turning a wheel at the further end of the shaft. The distance the knife was extruded was registered on a scale of millimeters indicated on the shaft. Both instruments were provided with efferent and afferent tubes through which water ran to keep the point of the instrument from attaining too great a temperature.

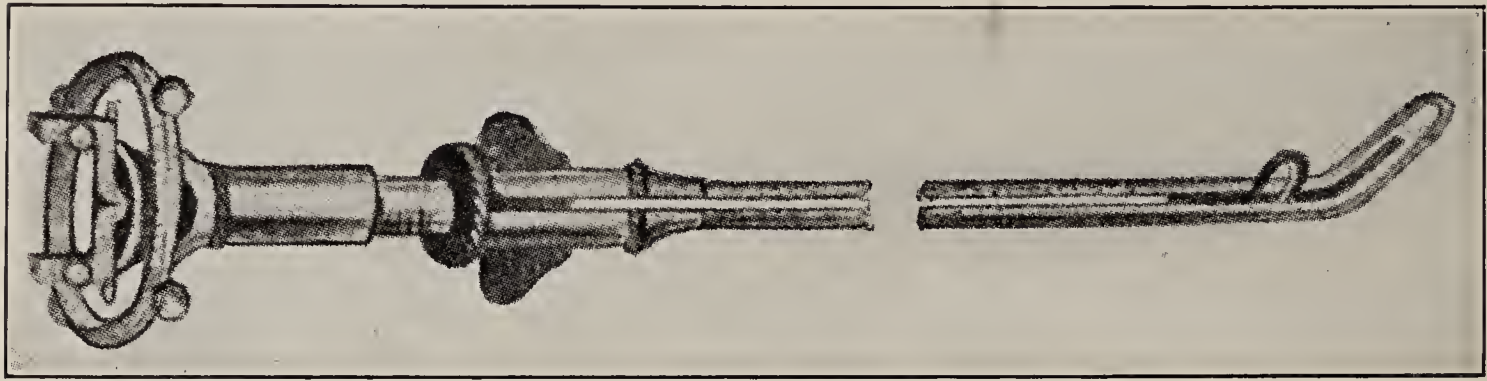

Fig. 3. Bottini's Galvanocautery. (From Randall's *Prostatisme sans prostate,* N. Y. Med. J., Dec. 4 and 11, 1915.) This was modelled upon Mercier's instrument, consisting of a male and a female arm; the male part carrying as a beak a platinum knife, which was extruded from the inside of the female section by the turning of a rondelle at the other end, which controlled an Archimedic screw. Two wires inside the male shaft conveyed an electric current to the knife, which was made of platinum instead of steel; and without, the instrument was equipped with small afferent and efferent tubes through which an irrigator effected a continuous inflow and outflow of water, which kept the main part of the instrument cool and prevented burning of the tissues other than those it was intended to treat.

Freudenberg's work. Though Bottini himself seems to have achieved very satisfactory results with this device, most of those who tried to follow his lead appear to have fallen into difficulties and to have abandoned the procedure as too dangerous for general employment. A full quarter century elapsed before it was revived with any enthusiasm. But in 1900 Albert Freudenberg, of Berlin, presented a number of cases of urinary obstruction which he had been able to relieve by the use of a method for which he accorded credit to Bottini. Freudenberg devoted his attention to improving his technique, and succeeded in doing this after several years by combining the cautery with the cystourethroscope which had been produced by the combined efforts of Goldschmidt and the two Wossidlos. In the third year after his original presentation he was able to exhibit 61 patients on whom he had performed a total of 77 “ Bottini-Freudenberg operations.”

From the literature Freudenberg also collected a total of 683 cases in which an identical, or very similar technique had been used, of which he claimed 88 per cent. had turned out well. He explained that by "cure" was meant that the patient "should be absolutely free from the need of a catheter, and should void his urine without any burden or annoyance; that no residual urine should persist — or, at least, only a very small amount of urine should be retained in the bladder." If we accept these limitations, it at once appears that his original reckoning of "cure" in two-thirds of the cases should be reduced to about one-third. His final reckoning was: Mortality, 4½ to 5½ per cent.; unsuccessful results, 6½ per cent.; good results, 88 per cent.

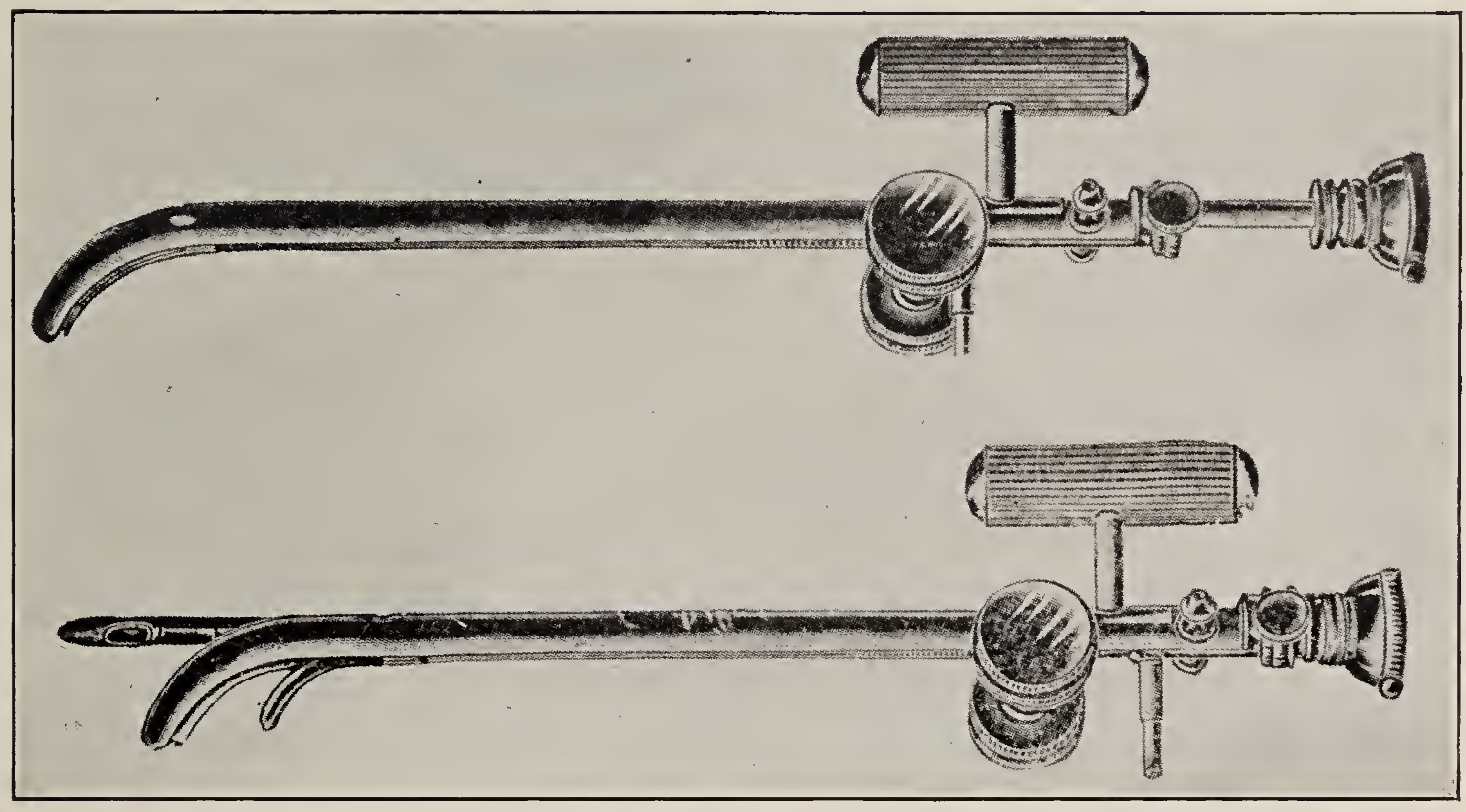

Fig. 4. Freudenberg's cystoscopic prostatic incisor. This combined Freudenberg's earlier modification of Bottini's design with Wossidlo's cystoscopic instrument. The cystoscope was used as an obturator while the instrument was being introduced into the bladder, and was so arranged as to be capable of being turned and shifted from a tube attached to the posterior surface of the shaft, while the wires carrying the current to the platinum-irridium knife ran in a groove on the anterior surface of the shaft. After the beak was completely within the bladder, the cystoscope was pushed forward, the beak turned to one side out of the range of vision, and cystoscopic exploration of the bladder and prostate carried out.

Progress in the twentieth century. — Thus, even before the introduction of modern electro-surgical methods, the management of vesical neck obstruction by intraurethral surgery was showing results which compared favorably with open operation. The instrument which Freudenberg had now perfected was described by him in the following terms: "The instrument is made on the basis of the Nitze operating cystoscope, and can be rotated and pushed backward and forward by a tube on the level with the front part of the shaft, while the conduction to the platinum shaft slides to and fro in a groove on the front part of the shaft, and by a cog-wheel, the turning of which at the same time indicates the length of the incision. The instrument is then passed into the urethra closed, the cystoscope serving as an obturator; after the beak is placed within the bladder, the cystoscope is pushed forward, and one can, by turning the beak toward one side and out of the field of vision, explore the bladder and prostate. While doing this the final decision can be made as to which part of the prostate is to be subjected to operation; the beak can be placed at the selected point, and the position of the beak can be verified. The cystoscope and the other parts of the instrument are then brought into position by manipulation of the screw. The incision is then made with the wheel as an indicator of its length. The largest incision possible is $4\frac{3}{4}$ cm. If there is much hemorrhage — so that it is desirable, before making another incision, to rinse out the instrument — or if the incandescent lamp goes out during the course of the operation, the cystoscope is withdrawn, and the bladder emptied and re-filled with ease through the extra tube. The cystoscope is then reinserted. The entire contrivance does not have to be withdrawn from the bladder."

For this instrument Freudenberg was able to gain sufficient publicity to popularize its use on both sides of the Atlantic. It has been necessary to give considerable attention to the model for which he was responsible because it is so much better known than the others which I am about to describe.

Goldschmidt. During the second decade of the twentieth century, the idea of operating by the intraurethral route upon the obstructed vesical neck seems to have taken hold of many minds in widely separated places. While Freudenberg was laboring to resuscitate Bottini's method and make it practical, Goldschmidt and the two Wossidlos were attacking the problem from another angle. Goldschmidt's instrument consisted of a straight fenestrated tube with a lamp, which he at first placed at the closed end of the tube but in later models made flat and put parallel to the optic. While no cautery feature was incorporated in it, it was possible to pass a cautery through it, although it was not adapted to making local applications. The mechanism for moving the cauteries or other instruments and changing the angle of observation was very complicated, and so delicate was the entire device that it was continually getting out of order. Another disadvantage was that all the auxiliary instruments, designed for use with this endoscopic tube, had to be held exactly in the median line. As nearly every one of them was fitted to a tube of its own, it was necessary repeatedly to withdraw tubes and replace them — to the embarrassment of the operator and the discomfort of the patient.

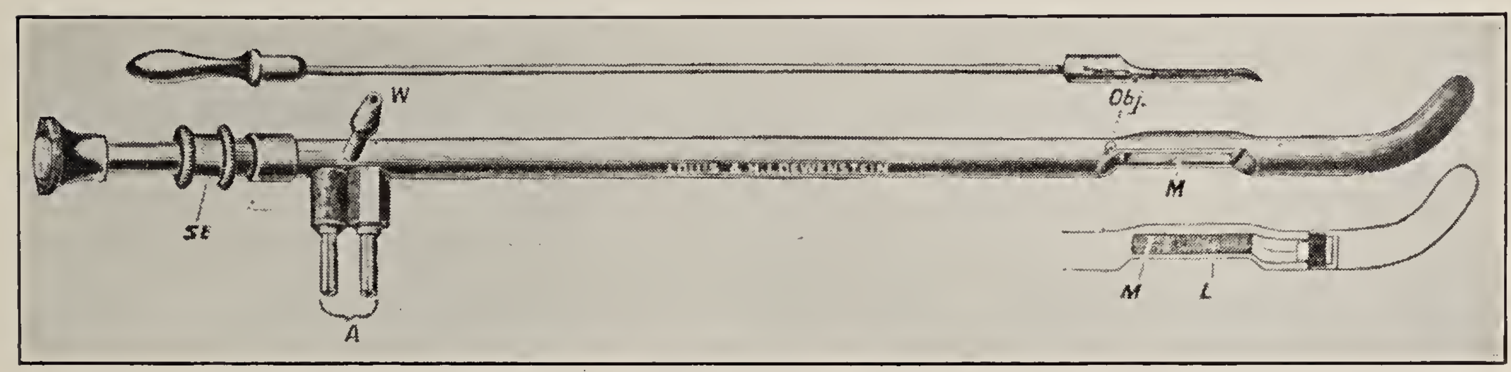

Fig. 5. Goldschmidt's design. The lamp, L, is here shown in the flat model, placed parallel to the optic, M. In an earlier model it was placed at the closed end of a fenestrated tube. The lenses collected the rays given off from the inside and end of the lighted tube, permitting a view of the interior to be obtained at the end of the optic.

Goldschmidt's visualizing arrangement was, however, by far the best devised up to that time. By using cystoscopic optic and convex lenses of smaller diameter than the object to be looked at, he was able to widen the visual field appreciably. When the tube was lighted, the rays reflected from its walls and end were collected by these lenses, making it possible to obtain a view of the interior from the end of the optic. As had previously been done by other endoscopists, an ocular was arranged so as to enlarge this view. Water was used for dilatation, but, as early in his experimental work Goldschmidt found only a little dilatation to be necessary, only a small amount was required to make a uniform tube of the urethra, in which his instruments could be manipulated with facility. An irrigating tube occupied the space between the endoscope and the optic, while the vesical end could be fitted with either a rounded or bill-shaped point which was inserted with a well-fitting obturator into the urethra. This permitted cleansing solution to run from an irrigator into the water chamber. After the urethra had been washed out, the obturator was withdrawn, the water-chamber closed, and the electric equipment (for lighting) connected.

Work of the two Wossidlos. The instrument resulting from the ingenuity of the two Wossidlos improved upon those just described in several important particulars. Freudenberg states that he was " obliged to make several objections " to the original Wossidlo presentation, but it is noticeable that no sooner did the Wossidlos produce a workable cystoscopic instrument than he seized upon the idea for the improvement of his own cautery device. He did, however, give full credit to Erich Wossidlo, and Hans Wossidlo was equally punctilious in according precedence to Goldschmidt in the use of the lamp.

The improved Wossidlo instrument had a bend in the endoscopic tube toward the convex side, which considerably enlarged the visual field and increased the accuracy with which a diagnosis could be reached. He attached a small tube at one side, through which air might be forced with a bulb, which gave better distention of the urethra with the employment of less pressure. A cone was arranged at the vesical end of the tube, which securely shut off the opening into the bladder. A drainage tube attached to the instrument's shaft permitted a thorough irrigation of the field without too rapid filling of the bladder — which was one of the greatest drawbacks to Goldschmidt's design inasmuch as, when the Goldschmidt optical tube was in place, the fluid could escape nowhere except into the bladder.

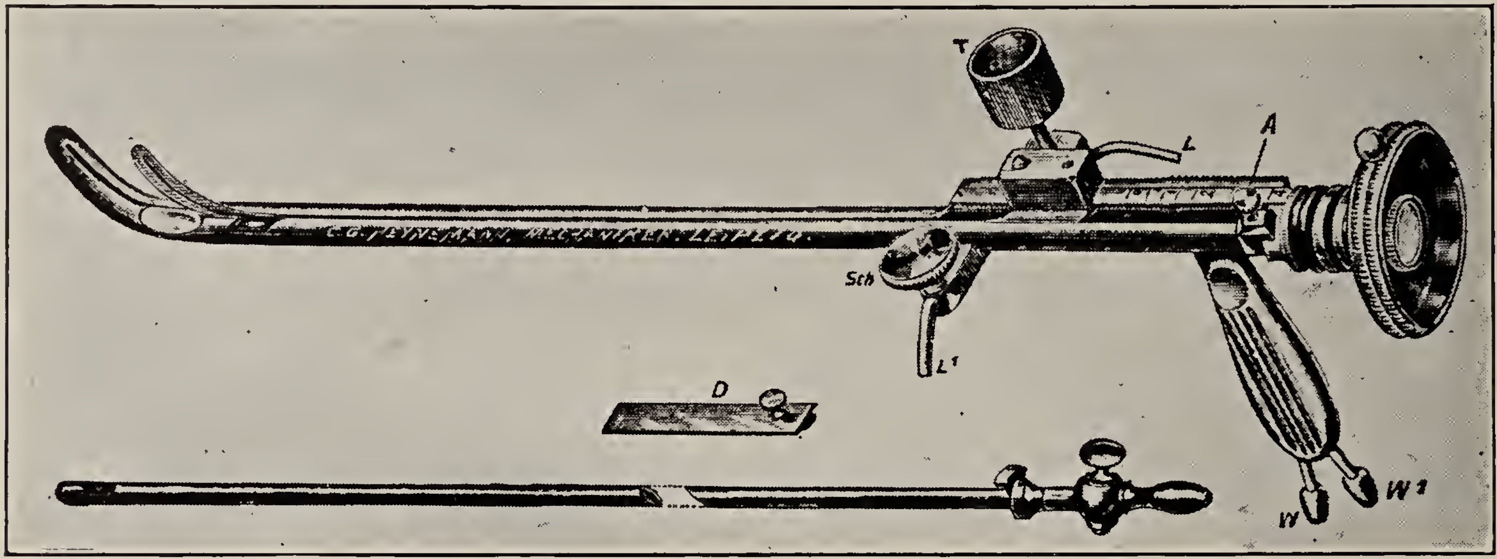

Fig. 6. Erich Wossidlo's incision cystoscope. The male portion, which carried the knife, was placed beside the optical apparatus, so that prism and lamp were upon the side of the beak. A catheter, which could be introduced in place of the cystoscopic portion of the apparatus, is shown in the lower figure.

Erich Wossidlo finally succeeded in so altering the structure of the tube itself that it was no longer necessary to withdraw it every time the operator wished to change instruments. The endoscopic tube remained in the bladder throughout the entire procedure, and the instruments could be used through it at various angles, not being rigidly confined to the median line, as in the Goldschmidt tube. The operator made use of the optic to decide where he wished to begin work. He then removed the ocular, opened the cock on the shutter, passed the desired instrument through the opening below the optic, and replaced the ocular. If he were using the galvanocautery knife, he was able to recognize what it was

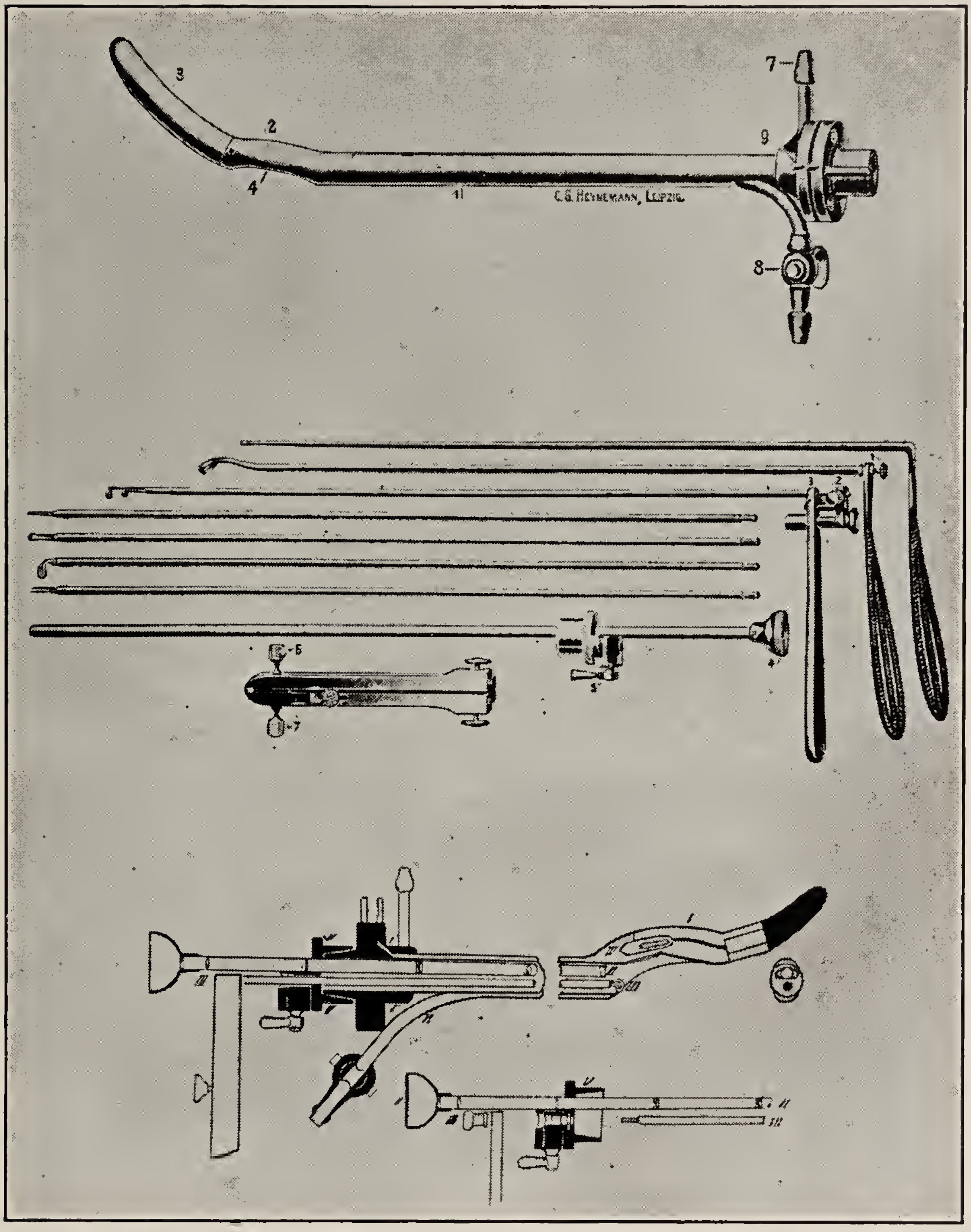

Fig. 7. Later form of the Wossidlo instrument. *a*. Hans Wossidlo's urethroscopic tube. *b*. Erich Wossidlo's operative armamentarium for use with the endoscope. *c*. Schematic section of the apparatus.

b–1, olive-tipped sound; *b*–2, curette; *b*–3, sharp forceps; *b*–4, *b*–5 and *b*–6, cautery electrodes; *b*–7, double electrolytic needle, and *b*–8, operating telescope.

c–1, Tube; *c*–2, telescope; *c*–3, cautery; *c*–4, lamp; *c*–5, diaphragm for outside closure; and *c*–6, outflow tube.

The sharp forceps was used to remove polyps, particularly those situated on the vesical side of the sphincter. The cauteries had to be introduced alongside the telescope, and telescope and cautery introduced together into the sheath. All the instruments were inserted at the distal (vesical) end, and then pushed through to the observation end, after which handles were attached to them. In the schematic representation the urethroscope is shown with the operating telescope in place, with cautery introduced. The lower figure shows how the cautery is inserted through the diaphragm for outside closure.

accomplishing by seeing fine gas bubbles rising, while, after a few seconds, the affected tissues would begin to turn white.

Wishard's contribution. In 1902, William N. Wishard, of Indianapolis, published an account of a method of treating prostatic hypertrophy which he had first used in the year 1890. The procedure at first consisted in introducing a small tubular rectal speculum through a perineal opening, passing a cautery through this, and applying it to the vesical neck obstruction, light being supplied by a head mirror, as in rhinological procedures. He later devised an instrument embodying these principles, and still later combined with it the Kock air-dilating cystoscope. This was some years before the Goldschmidt instrument was made available, but in this country no skilled instrument-makers, such as were to be found in every great Teutonic medical center, were at hand to serve the surgeon in elaborating his ideas. Wishard was never able to overcome the mechanical difficulties encountered, and although he claims to have used his device " through the natural channel," it cannot precisely be classed as capable of *intraurethral* employment. It remains, however, an important contribution to the use of the cautery under direct observation in the treatment of vesical neck obstruction.

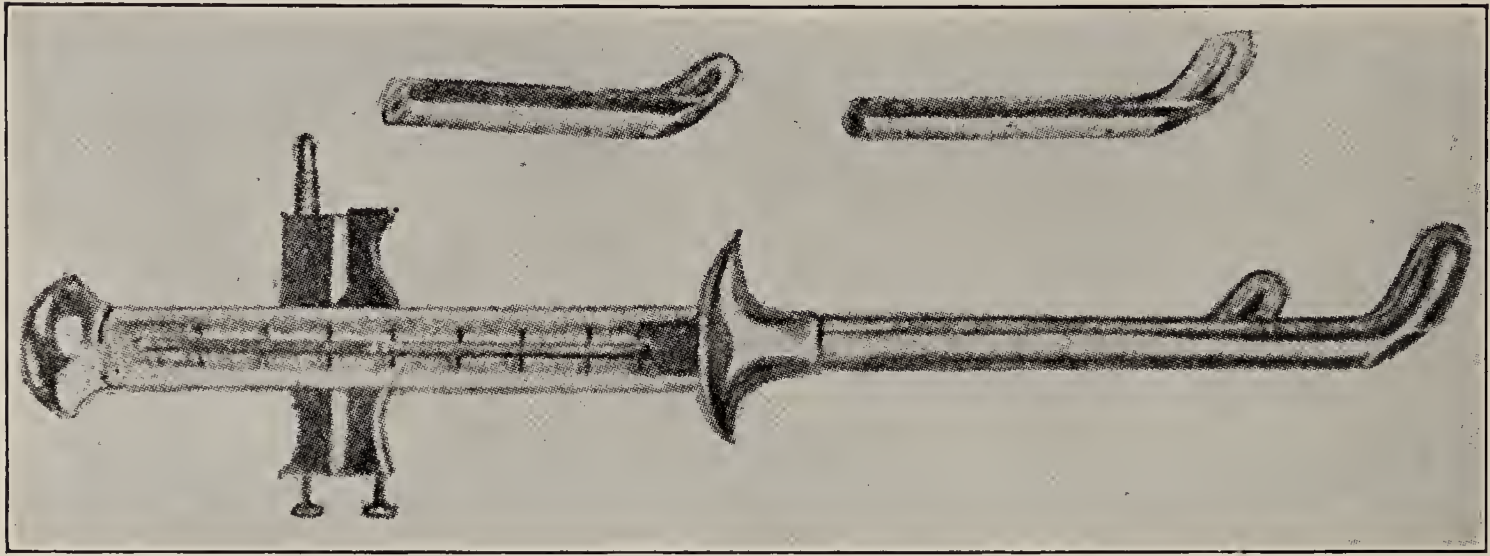

FIG. 8. Chetwood's galvanocautery. This instrument was used through a "buttonhole" cut in the perineum, which was not properly "intraurethral" technique.

The work of Chetwood. An account of the cases of what he termed " prostatism without hypertrophy of the prostate " was published by Chetwood in 1905, giving his experience with vesical neck excision. His procedure consisted in making a " buttonhole " in the perineum, through which he was able to palpate the obstruction in the urethra so as to decide on the best means of excising it. Chetwood also devised a cautery incisor which he applied by way of the perineal opening. This intervention, though it cannot be classed as " intraurethral," was a distinct contribution to advance in the surgery of the vesical neck. Alexander Randall later described Chetwood's procedure as "practically a Bottini-Freudenberg operation performed after better diagnosis and under better control."

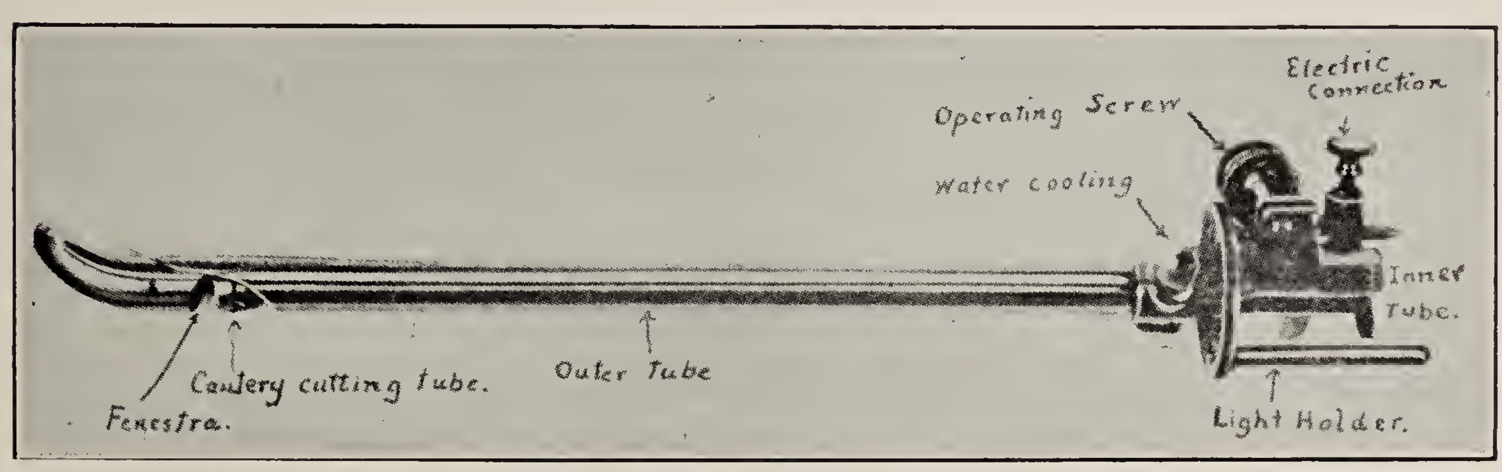

Fig. 9. Young's cautery punch, 1911 model. In this model the original inner cutting tubular knife was replaced by a tubular cautery. In order to keep the instrument cool, the outer portion was made of two tubes with a space between them for irrigation. This was the original "cautery punch." (Practice of Urology, Vol. II, p. 489.)

Combination of punch with cautery. In 1911 Young replaced the inner tubular cutting knife of the prostatic punch he had first used in 1909 by a tubular cautery. Later still he abandoned the cautery, but his punch has since seen continuous employment and steady improvement in the hands of its originator and his pupils, so that it remains to-day the prototype of most of the instruments of the punch class.

In his text-book Young gives this account of the genesis and evolution of the punch instrument:

> "Shortly before we had devised a curved posterior urethroscope. It occurred to us that if a fenestra could be placed on the posterior surface of this urethroscopic tube, the median bar would drop into it when the instrument was passed into the urethra, and that a cutting tube passed within the outer tube could remove the median bar more radically than it could be done from the bladder through a suprapubic wound . . . Accordingly an instrument of this type was designed, using one of our posterior urethroscopic tubes, the exterior diameter of which was 28 F. We provided a fenestra about 1.2 cm. long, after filling up the aperture near the inner end, and an inner cutting tube of steel. It was also fitted with an obturator, and externally carried a light-holder for urethroscopic observation . . .
>
> Very early in our operative work with the punch instrument we encountered cases in which the hemorrhage was annoying. In some cases it was necessary to employ a large catheter and not infrequently clots had to be evacuated by suction. Accordingly in 1911, while in Berlin, we designed and had Löwenstein

construct a punch instrument in which the inner cutting tubular knife was replaced by a tubular cautery with which the bar, entrapped in the fenestra of the punch, was to be excised. In order to keep the instrument cool we made the outer portion of two tubes with a narrow space between them for irrigation."

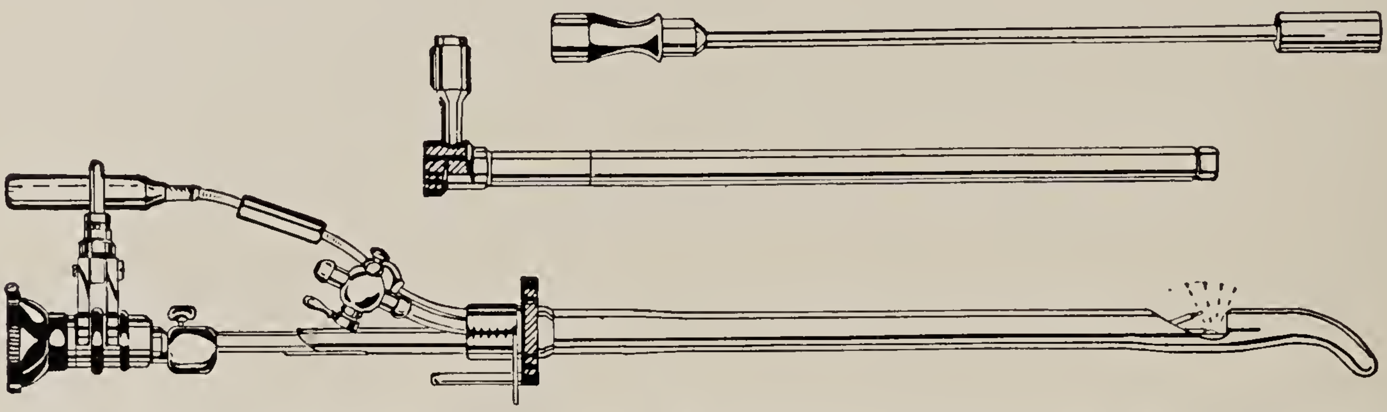

Fig. 10. Caulk's first cautery punch. The general design of the Young punch was modified by introduction of a cautery knife. No irrigation system was provided.

Almost at the same time that Young made use of this cautery adjunct to his own instrument, A. R. Stevens adapted the high frequency current (which Beer had already employed in fulguration of bladder tumors) to the removal of hypertrophied tissue at the vesical neck. The regulation fulguration wire was carried through the urethra in a standard catheterizing cystoscope. This device more nearly resembled those now in use than any previously brought out.

From this period the instruments developed fall into two classes — the cystoscopic type being naturally distinct from the punch type, of which a considerable number followed the introduction of Young's model. It was in 1920 that John R. Caulk, making use of Young's outer tube and fenestra, and omitting the double walls with which Young had equipped his instrument for use in connection with the cautery, developed a " cautery punch " which has since seen wide employment. The instrument was passed in the usual way, the tissue to be removed identified endoscopically, and engaged in the fenestra. " The cautery blade is then passed through the sheath until it engages the obstruction. In the meantime, the left hand which is firmly holding the orifice within the slot of the instrument, is never budged from its original position."

McCarthy's earlier work. In an address made before the Bellevue Hospital Alumni, on October 7, 1931, Joseph F. McCarthy stated that the first reported cases wherein prostatic encroachment on the urethra and vesical outlet had been treated endoscopically with the high frequency current were exhibited by him nineteen years previously before the Urological Section of the New York Academy of Medicine. He added, however, that "the outcome of subsequent attempts in the general application of this method were such as to lead to the conclusion that, with the instrumental and electrical equipment of that day, it was not equal to the exacting demands of this highly technical procedure."

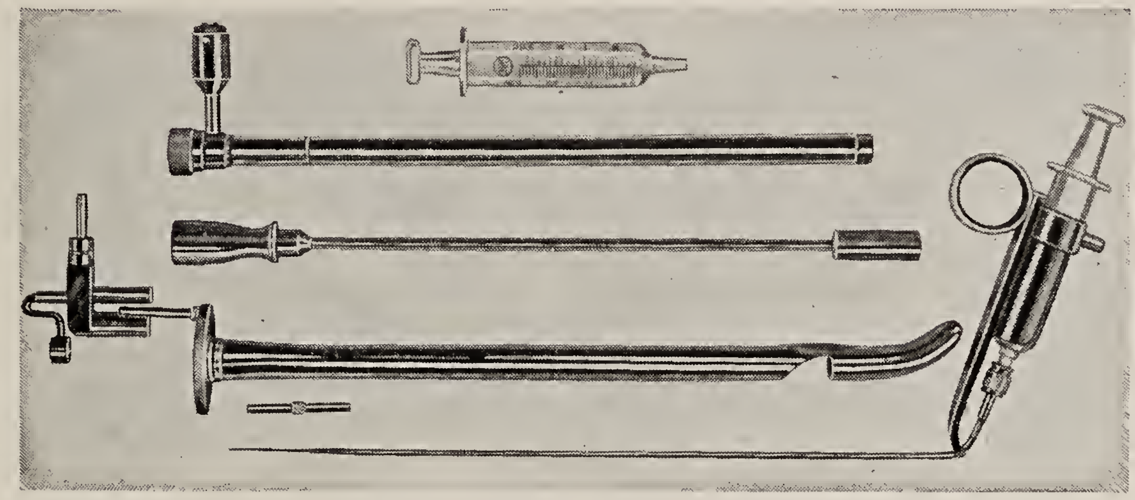

Fig. 11. Caulk's later model. (Cuts for Figs. 10 and 11 kindly supplied by Dr. Caulk.)

Stern's instrument. More successful than this early attempt of McCarthy was that of Maximillian Stern, who, in 1926, gave the following account of an appliance of the cystoscopic type designed by him for resection of obstructions at the vesical orifice:

"This is essentially a cystoscopic instrument provided with two lens systems or telescopes. One is of the indirect vision type for examination and diagnosis, to be employed before operating, and the other is of the direct vision type, to be employed while operating in order that a prospective view may be obtained of the entire prostatic urethra during operation.

The instrument is about two inches (5 cm.) longer than ordinary cystoscopes for application in advanced prostatism, and is made in size 27F, though smaller sizes can be made without difficulty. It comprises a sheath with its obturator and examining telescope, as stated before, in addition to the working parts, which are assembled in a compact bundle made up of the direct vision telescope, a light carrier, a water conduit, and a cutting loop or active electrode . . . the sheath carries a receptacle for the indifferent pole of the cutting current . . . the instrument is bipolar, no plate or pad being used under the buttocks as the indifferent pole.

The cutting loop consists of a small ring of tungsten wire about 0.5 cm. or less in diameter, placed at right angles on the end of a peculiarly insulated shaft, and connected at the working end of the instrument in such a manner as to slide backward and forward in the fenestra . . . a manually controlled gear mechanism insuring even movement and perfect control . . . this part carries the active pole of the cutting current.

The tungsten loop is situated just in front of the eye of the telescope and can be seen resting against the protruding tissue in the fenestra just before its backward thrust begins, and is visible throughout its entire excursion to the distal end of the fenestra . . . The size of the gutter which it makes is larger . . . than the outside circumference of the loop and . . . is probably increased by dehydration of the tissue to some extent.

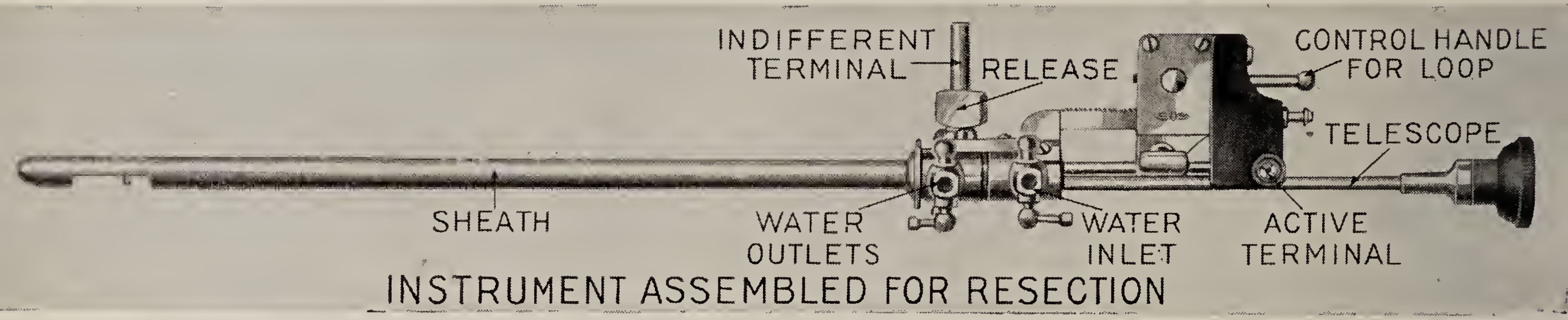

Fig. 12. Cystoscopic "resectotherm" of Maximillian Stern, (From Jour. A. M. A., lxxxvi: 1726, Nov. 20, 1926.) This instrument differed from those preceding it, in that it was provided with two lens systems; one, the indirect vision type for examination and diagnosis; the other, the direct vision type for operative work. The cutting device consisted of a loop of Tungsten wire.

The resectotherm is an apparatus which delivers a radio-frequency current of low voltage and . . . can be delivered in a continuous flow through the cutting loop under water, and across a gap . . . [which] . . . makes possible the employment of a bipolar instrument. There is no tendency to sparking, and accordingly . . . slough and secondary hemorrhage are eliminated."

Rose's prostatic punch. Coincident with improvements in the cystoscopic type of instrument, the prostatic punch was receiving attention and modification. More than a year before Stern's publication, the design of an improved punch was given out by D. K. Rose, of St. Louis. He pointed out that in no previously designed instrument of the punch class had

". . . an attempt been made to prevent hemorrhage by cauterization with a visual instrument, so that several punches from the prostatic orifice can be made at one sitting . . . under direct . . . vision. These important factors are accomplished with the instrument described.

First, the instrument affords vision by having a large oval, single sheath for cutting and cauterizing, which can carry illumination throughout its length. Second, it provides hemostasis by cauterizing with an electrically heated platinum plate which immediately follows the cutting (steel) knife. The knife, cauterizing plate and conduction wire are a part of, or incorporated in, the narrow sliding portion of the sheath, which is controlled by a thumb ring fastened to an ebony and asbestos and steel plate, placed at right angles to the shaft. The ease of cutting with a sharp blade renders unnecessary any other than thumb pressure, which is applied to a point well out of line of vision. The first cylinders of prostatic tissue are removed with long forceps, or pushed up into the hollow tip with a long wooden applicator. A 110 alternating current is used for heating the cautery . . . Success in overcoming the mechanical difficulties of this instrument is largely due to R. H. Tontrup, instrument maker, St. Louis."

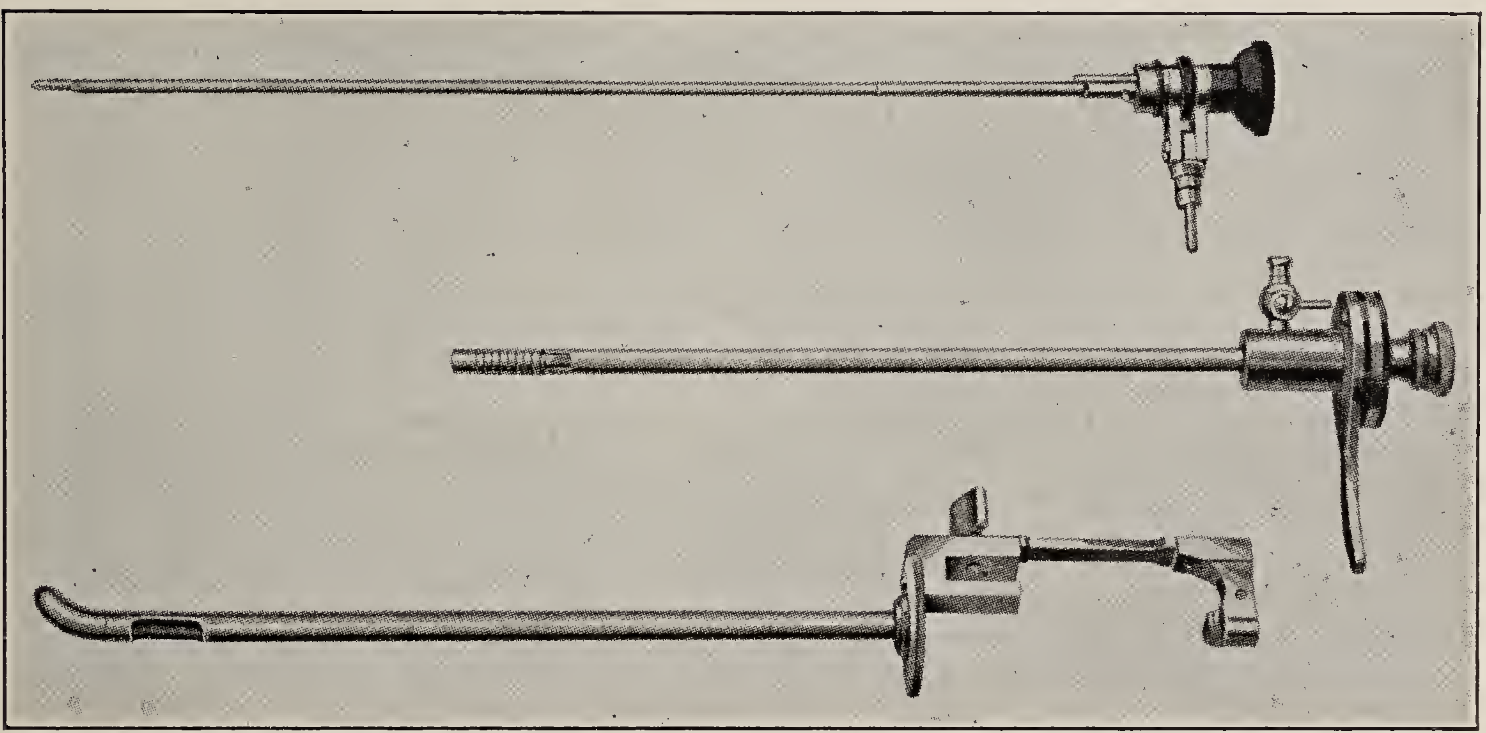

Fig. 13. Rose's prostatic punch. (From Surg., Gynec. & Obst., July, 1925.) With this instrument the cutting is done with a steel knife, but is immediately followed by an electrically heated platinum plate, which serves to close any bleeding points left by the cold knife.

Collings' "electrome." About the same time as Rose's contribution, and also before Stern's presentation, Collings brought forward his "electrotome," a device for providing a high frequency electric cutting current. Collings' procedure for the relief of obstruction at the vesical neck differed slightly in aim from that of the operators whose designs have just been enumerated in that, while the punches and cutting electrodes *excised* pieces of tissue, the high frequency current destroyed the tissue *in situ*, the barrier being burned away instead of cut out. The current was applied through a McCarthy panendoscope.

Interest in the subject of intraurethral electrocautery excision of vesical neck obstruction now became general. In the five years following Stern's publication there was an unprecedented production of mechanical devices to facilitate treatment of this urologic lesion.

Foley's design. Among the instruments, descriptions of which have been quoted in the preceding paragraphs, it seemed to Frederic E. B. Foley that none permitted a sufficiently extensive resection in those cases where the obstruction was a large one. To meet this need he designed a modification of the previously used ones which he describes as follows:

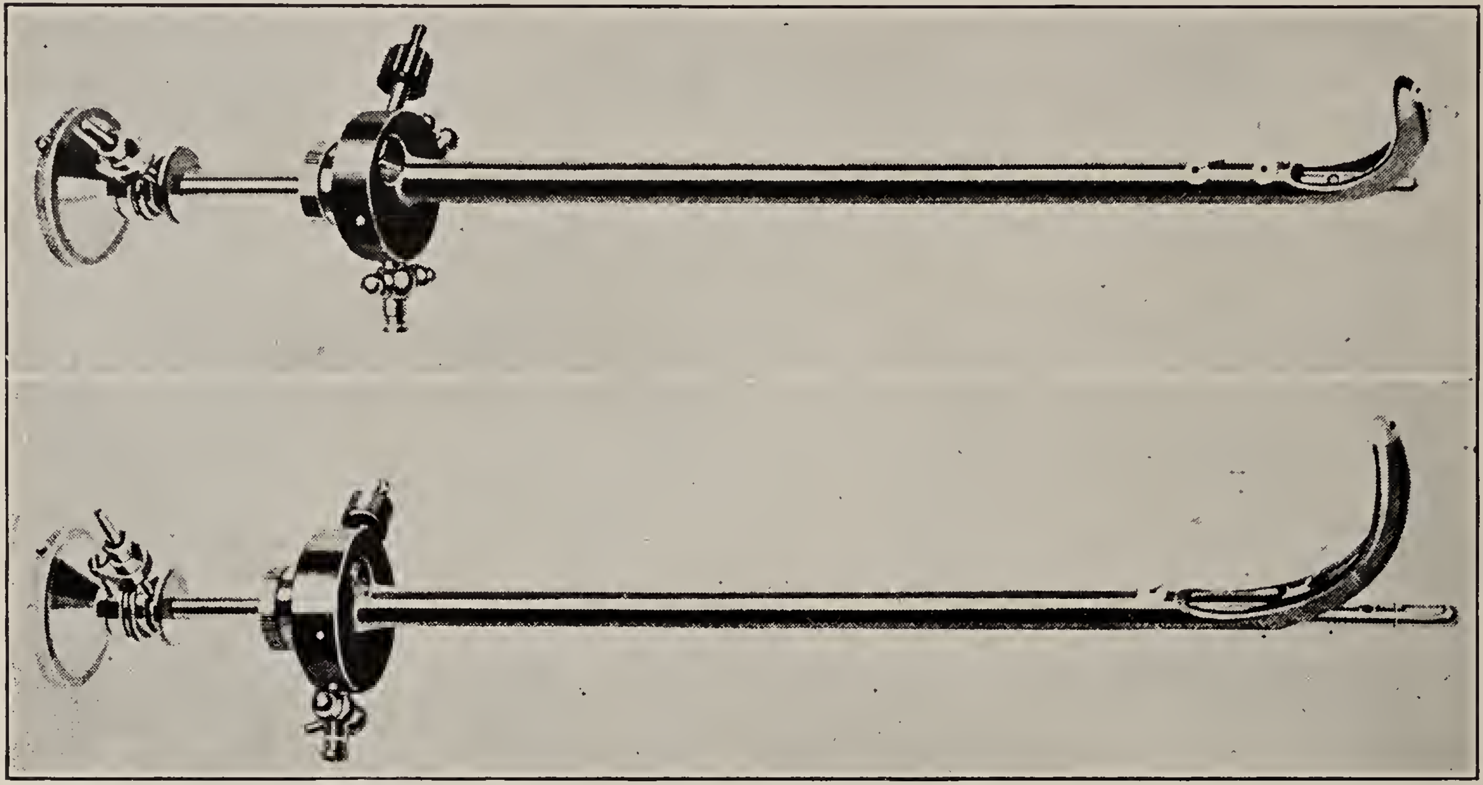

Fig. 14. Foley's device for "cystoscopic prostatectomy." This instrument has two forms, as shown in the photograph. One is suited for the division of median bars and vesical neck contractures; the other has a beak capable of projecting the electrode sufficiently to make excision of any size desired, thus rendering possible an attack upon enormously hypertrophied prostatic lobes. The two designs in the picture are placed side by side for contrast as to the shape and dimensions of the beaks. (From Journal of Urology, xxii: 289, March, 1929.)

" Excision of the obstructing portion of the prostate is accomplished by a fine wire electrode to which a high frequency cutting current is supplied. The electrode is supported by a cystoscopic sheath of insulating material made in the form of a hollow urethral sound of Van Buren curve. For making the incision the electrode is drawn taut like a bow-string stretched across the concavity of the curved end of the sound. Through the sheath may be introduced a combined telescope and light carrier . . .

The instrument . . . has . . . two forms. One is suited to division of contractures or excision of bars and small mid lobes where extensive removal of tissue is not required. The other has a longer and more deeply curved end. The configuration of this beak projects the electrode to an extent that makes possible an excision of almost any desired extent and permits the extensive resection of tissue required in cases of large adenomatous hypertrophy . . . By means of a high frequency cutting current snare the excised mass of tissue may be cut into small pieces for removal through a cystoscope . . . This instrument is of construction similar to the excisor . . . A right angle vision telescope and light carrier permit observation of the snare. The hemorrhage which may occur following an extensive excision is controlled by a specially devised hemostatic bag catheter . . . The excision is carried out under sacral anesthesia . . .

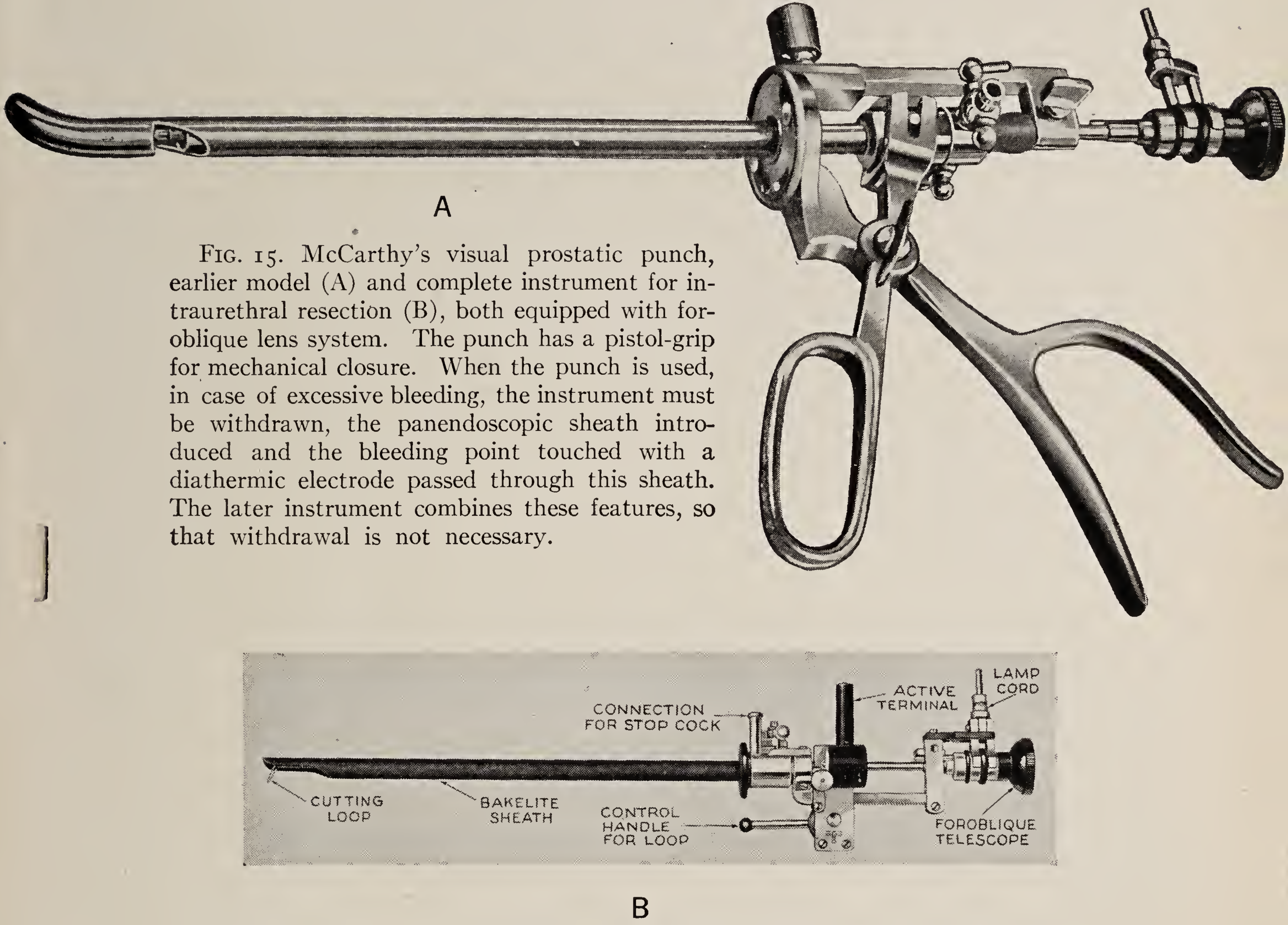

Fig. 15. McCarthy's visual prostatic punch, earlier model (A) and complete instrument for intraurethral resection (B), both equipped with foroblique lens system. The punch has a pistol-grip for mechanical closure. When the punch is used, in case of excessive bleeding, the instrument must be withdrawn, the panendoscopic sheath introduced and the bleeding point touched with a diathermic electrode passed through this sheath. The later instrument combines these features, so that withdrawal is not necessary.

The procedure here described represents a radical departure from any form of punch operation and is free from the limitations which the small bite of the punch imposes. At the same time perfect visual and mechanical control, which has not been secured in previous departures from the punch, is perfectly provided. The extensive excision of tissue possible with the procedure appears to make it capable of relieving not only obstructions belonging to the group of bars and contractures, but also those due to extensive benign adenomatous hypertrophy."

McCarthy's most recent contribution. In the year 1931 McCarthy modified his previous contributions to the mechanical equipment for dealing with vesical neck resection with several features which had never before been thought of. The troublesome conduction of heat from a metal sheath is avoided by using bakelite as the sheath material, and a special electric arc cutting electrode is supplied with a degree of power which makes it more useful for mastering the conditions of electrocautery resection than any similar device which preceded it. The special type of loop electrode supplied enables the operator to look through the originator's panendoscopic visual system directly upon the loop, without his vision being interfered with by any intervening wire or stem.

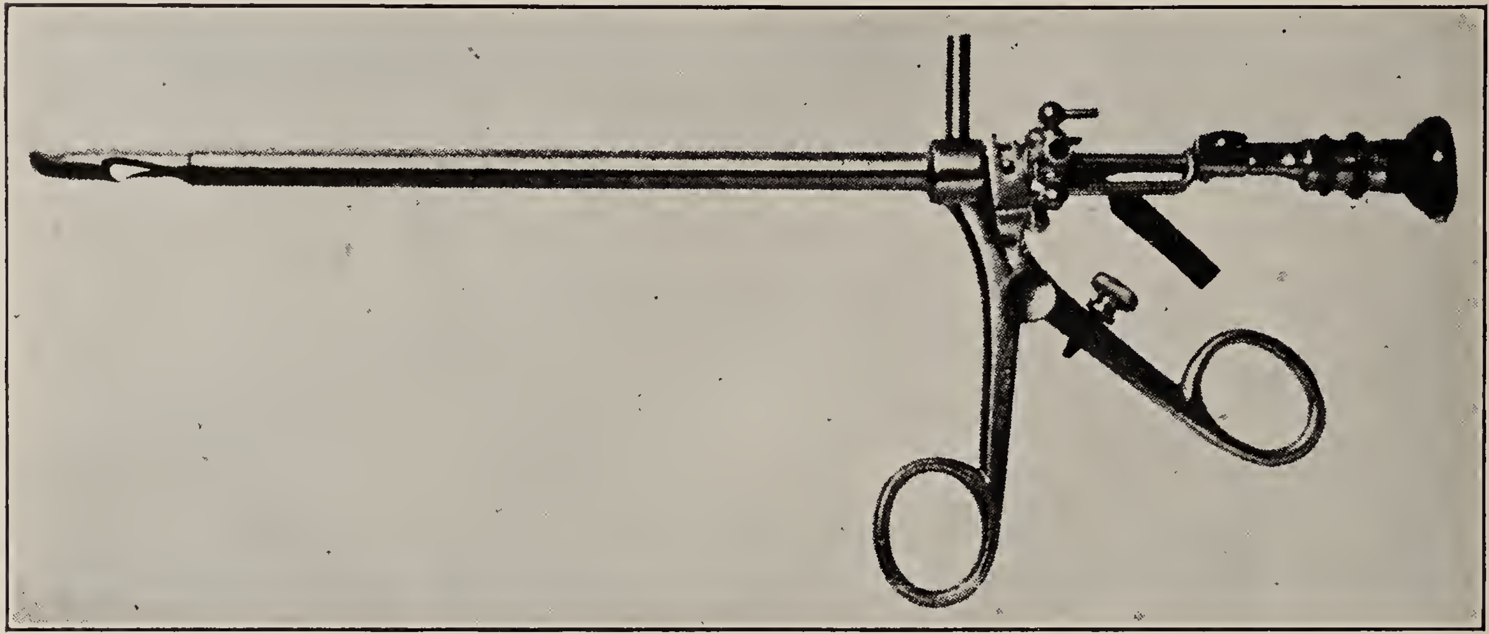

FIG. 16. Day's modification of McCarthy's punch. The addition consists of an insulated needle for preliminary desiccation of the tissue to be resected, obviating the use of high-frequency cauterization, should active bleeding occur.

In his presentation McCarthy emphasizes the necessity of making vesical neck resection a "hospital procedure," and the need for the operator to be thoroughly familiar with the use of the panendoscope and completely conversant with the anatomy and pathology of the bladder neck. After exploration of the field the operation

"... begins at the floor of the sphincter in the mid-line, with the cutting loop well extended into the visual field and behind the obstruction, the sheath of the instrument as far forward in the region of the verumontanum as is consistent with visualization and safety. One then contacts the cutting loop to the vesical aspect of the obstruction, holding the instrument in the left hand, the right grasping the steel arm controlling the movement of the loop. The current is then begun and the loop brought forward with a slow steady movement until it is completely within the sheath ... With the completion of the floor of the sphincter . . . one then approaches first one lateral lobe, and completes this in a manner similar to the floor. The other lobe is then attacked . . . The objective is . . . to remove the offending obstruction with as little bleeding and tissue coagulation as possible."

Day's modification of McCarthy's punch. McCarthy's earlier instrument for vesical neck resection has been modified by Day, who, in 1931, described his additions as follows:

> " With this instrument every advantage of the McCarthy punch is retained with the added insulated needle for preliminary electro-desiccation with the d'Arsonville current . . . the bite starts from the bladder aspect instead of the urethra as in the McCarthy instrument. It removes slightly larger bites of tissue . . . preliminary electro-desiccation obviates the necessity of high frequency cauterization in the presence of active bleeding, as is the case when the McCarthy punch is used. Even with my punch it is sometimes necessary to follow up with a bit of high frequency cauterization unless one has continued the preliminary desiccation to such a degree as to run the risk of devitalizing the tissues to an unnecessary depth. The ideal objective is a maximum of hemostasis with a minimum of tissue trauma by the high frequency current.

Revival of Stern resectoscope by Davis. Another renaissance of a pattern which had been unduly neglected was that which Davis recently effected for the Stern resectoscope. In addition to improving the electrical equipment, Davis recounts the alterations he has made in the Stern instrument in the following terms:

> " The original resectoscopic sheath consisted of a metal tube with a fenestrum $\frac{5}{8}$ inch in length near the beak, one-half the diameter of the tube in depth, with a beak $1\frac{1}{2}$ inches in length, the tip being curved distally to the fenestrum. The author's [i. e. Davis's] sheath consists of a metal tube with a fenestrum $\frac{7}{8}$ inch in length and three-fifths the diameter of the tube in depth. The tip is straight and $\frac{1}{2}$ inch in length, distal to the fenestrum. The sheath is 26 F. in diameter . . .
>
> The loop electrodes supplied with the original equipment were fragile. The active loop was very small in diameter permitting the removal of only a small section with each excursion. Imposition of a heat-producing current caused destruction of the loop. The author has succeeded in making a loop that is durable and permits the use of a most powerful current without the slightest injury to the loop."

The Braasch-Bumpus instrument for prostatic resection. Still another modification of a previously existing design is that which Hermon C. Bumpus recently made upon the well-known Braasch cystoscope.

The designer's description, which appeared in April of last year (1932), is herewith appended:

"The instrument . . . consists of a Braasch cystoscope, number 28 French, in which a fenestra has been made large enough to engage tissue to the amount of approximately 1 gram. The instrument is open at the distal end and the entire neck of the bladder can be observed before the obstructing tissue is engaged in the fenestra and hence the operation is carried on under full vision.

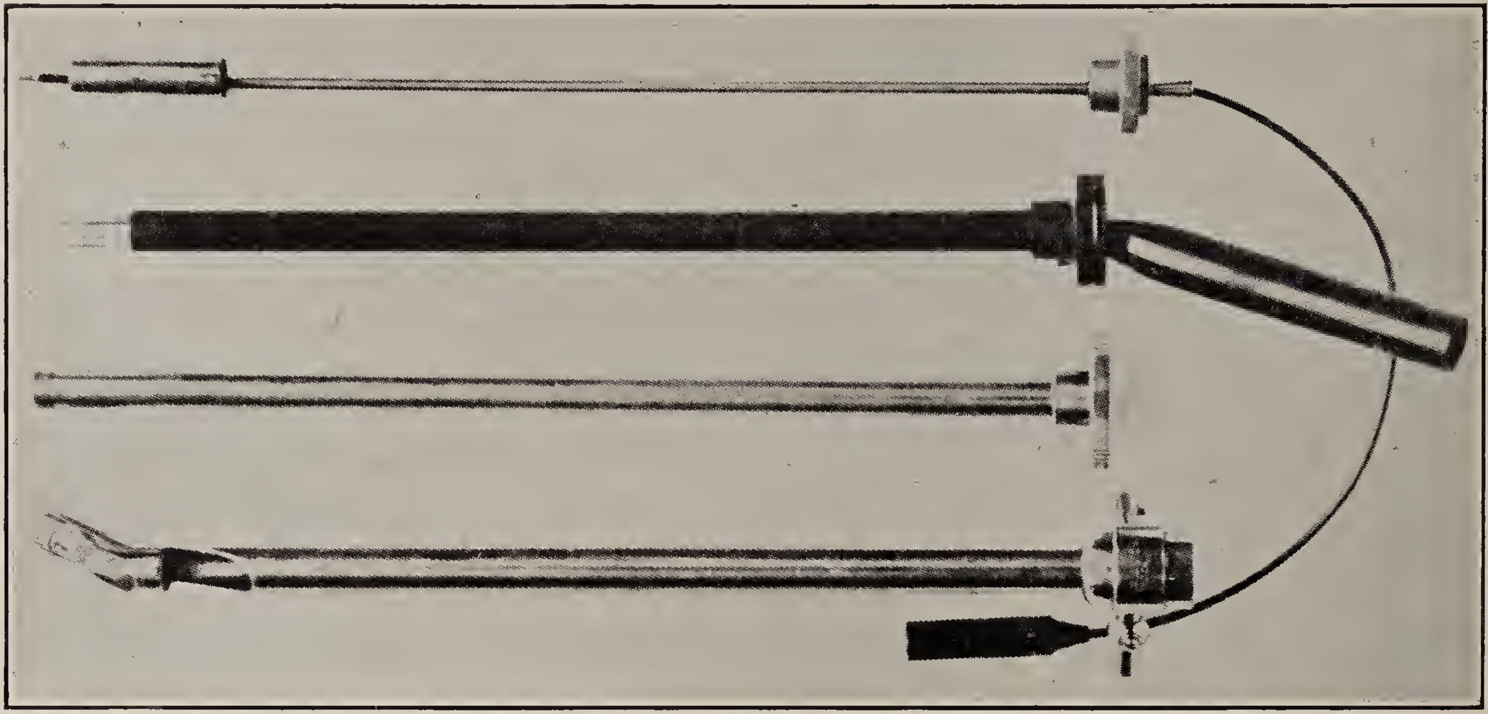

FIG. 17. Braasch-Bumpus instrument. The cystoscope designed by W. F. Braasch a number of years ago, has been fitted with a fenestra for the engagement of the tissue to be resected. The electrode used in conjunction with this consists of multiple needles. A tubular knife excises the vesical neck obstruction. A catheterizing guide closes the fenestra, converting the instrument into a direct cystoscope for examination of the field after the resection has been made.

After the tissue to be excised is engaged, the needle electrode which consists of insulating material of a diameter to fill the lumen of the punch, the distal end which consists of multiple needles, is thrust into the base of the portion of the gland to be removed, entering at exactly the place where the circumference of the tubular knife will cut. The current is allowed to flow for a few seconds, as the object is not to coagulate the engaged tissue completely, but simply to seal the vessels entering it. The electrode is then removed and the tubular knife is used to excise the tissue . . .

The instrument is equipped with a catheterizing guide which closes the fenestra and converts it into a direct cystoscope, so at the end of the operation the entire field of procedure may be examined and if any bleeding points persist these may be coagulated with the electrode passed through the catheter guide."

These various designs, whether of punch or cystoscopic type, repre-

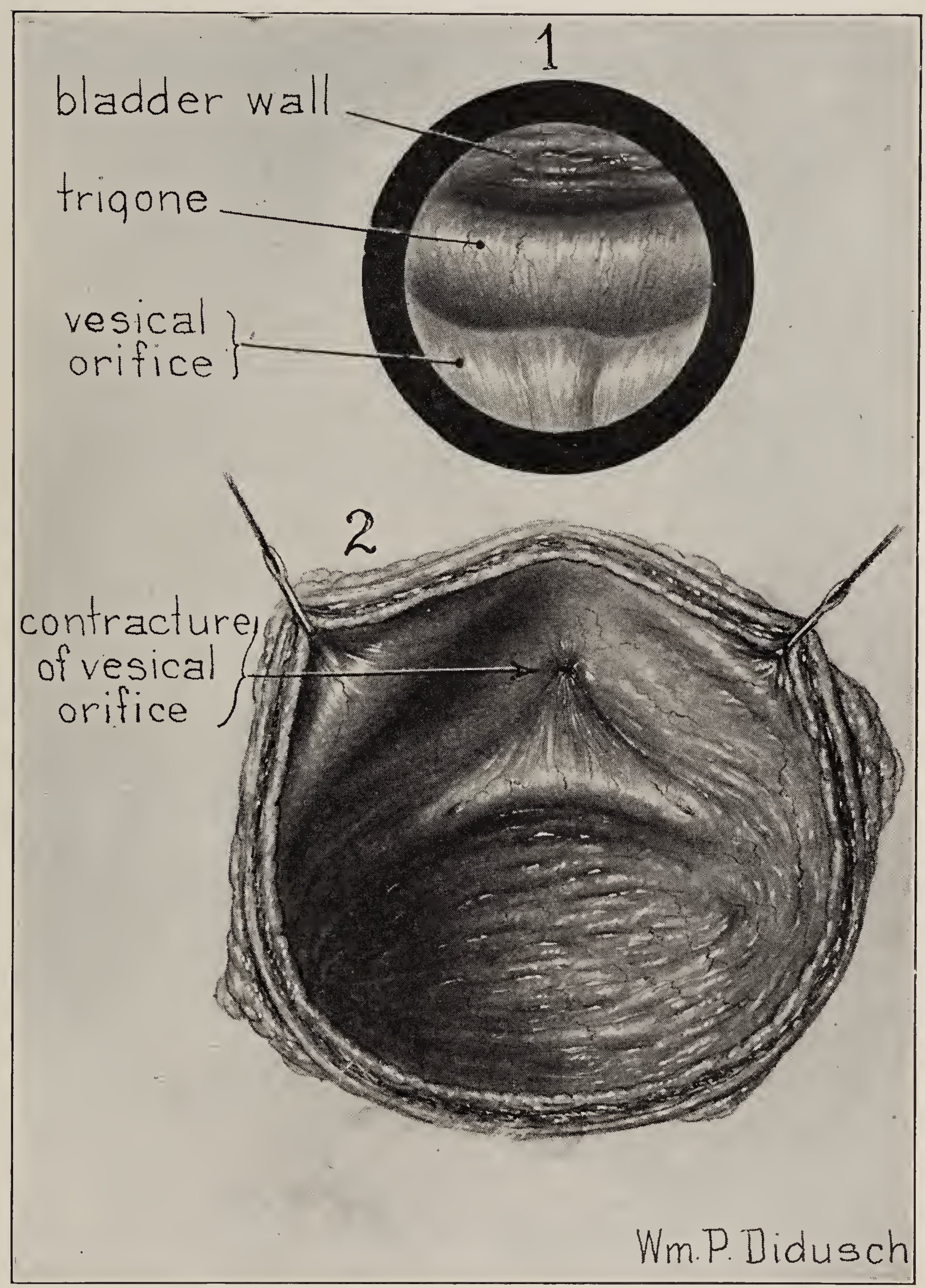

Fig. 18. Contracture of the vesical neck. (1) Cystoscopic view of contracture; (2) View of the opened bladder from above. (Courtesy of Amer. Journal of Surgery.)

sent a steady progression along the difficult road toward a perfectly satisfactory intraurethral technique for the removal of vesical neck obstructions. In general, the designs are similar, yet each new one embodied some special feature not to be found in its predecessors, and all contributed in greater or less degree to the advancement of the special science of urology, and in particular, the treatment of vesical neck pathology.

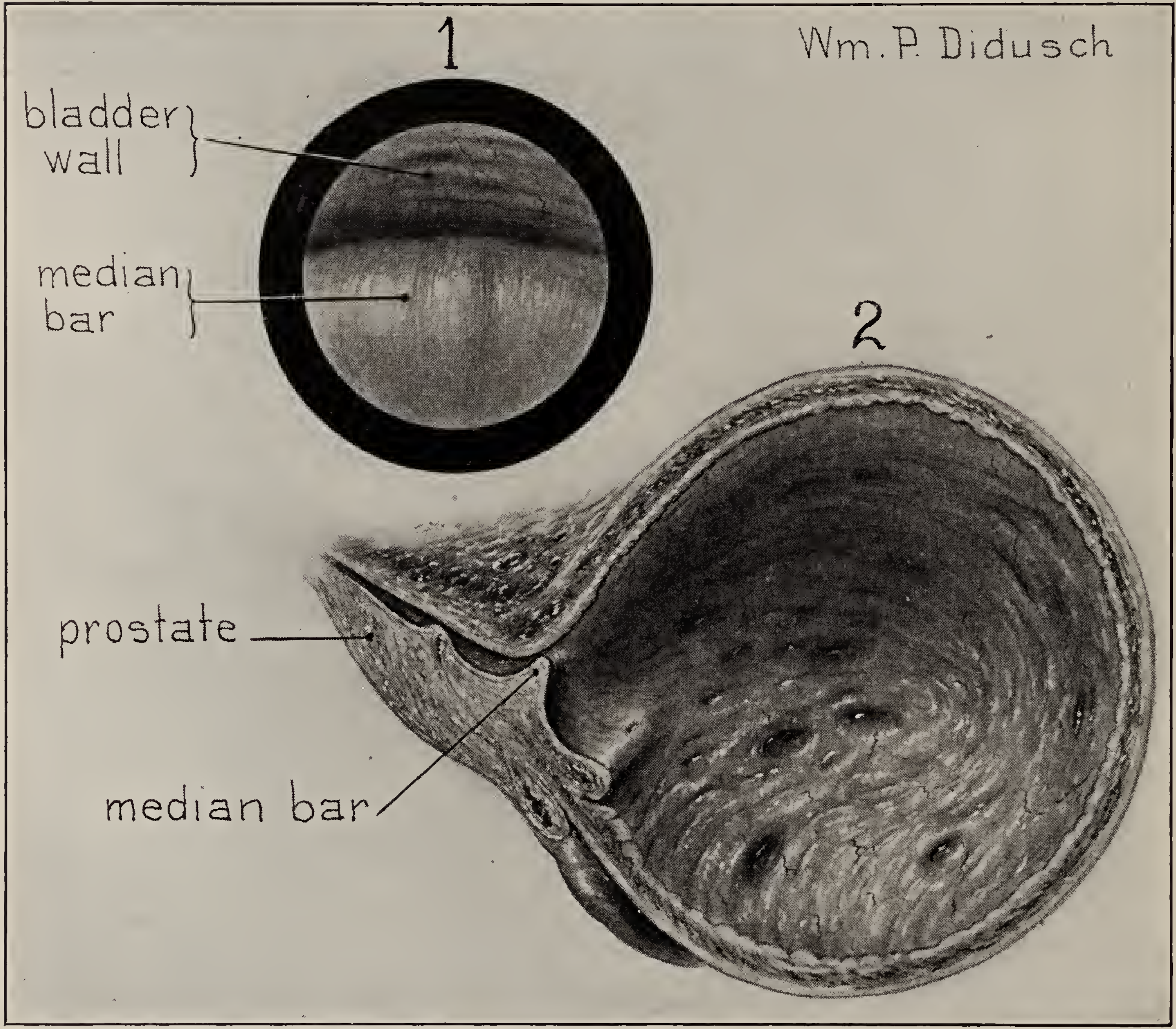

Fig. 19. Median bar obstruction. (1) Cystoscopic view of bar. (2) Sagittal section showing obstruction in its relation to vesical orifice, and interior bladder. (Courtesy of Amer. Journal of Surgery.)

I have been at considerable pains to collect pictures of all the instruments mentioned, but regret that it has proved impossible to make the collection complete. For most of the illustrations I am indebted to the originators of the designs, whose courtesy I take pleasure in acknowledging. A few I have obtained from periodicals, and — those of the nineteenth century — from books. My endeavor has been to get correct representations and to reproduce the inventor's own descriptions without discussion of their relative merits and of the advantages of different techniques. The interest is entirely historical; accuracy is of the highest importance, and the expression of personal opinion has no place in such a survey.

APPLICATIONS OF INTRAURETHRAL OPERATION

The increasing popularity of intraurethral intervention has faced us with new questions in prostatic work, for which answers must be found. As in open operation by either route, most rigid surgical precautions, and the best possible preoperative care and treatment are absolute prerequisites to success. These precautions are as important as the technique itself. While many failures were undoubtedly due to improper selection of cases, a still greater number occurred, I am quite sure, because the procedure was looked upon as of minor importance, and the strict supervision of every detail, which has done so much to raise the operation of prostatectomy to its present high level of excellence, was omitted.

Widening of operative indications. As our knowledge and skill have increased, the indications for vesical neck resection have been ever more widely extended. Just now there is, perhaps, a tendency to overdo the matter — to make use of intraurethral methods when open operation, or some other treatment, would be safer and more suitable. To overcome these bad tendencies, and to place this most useful procedure on a safe and sane footing, we should analyze the needs of each individual patient with most painstaking care, and make use of intraurethral methods only in those cases where they are unquestionably indicated.

Naturally, these methods will first be resorted to in cases where open operation is indicated but, for reasons which can well vary with each case, cannot be done. Chief among such contraindicating conditions might be named the existence of auricular fibrillation, or some other cardiac or vascular lesion, and the presence of a greatly hypertrophied middle lobe of the prostate, with one or both of the lateral prostatic lobes somewhat enlarged as well. The picture will usually be still further complicated by high blood pressure and some degree of deficient function on the part of the kidneys.

In individuals presenting any of these conditions the use of a general anesthetic will be quite out of the question. Yet, obstruction at the vesical neck will have brought about systemic conditions which must have relief if the life of the patient is not to be jeopardized. To such an individual the choice of intraurethral intervention offers practically the only solution of a most vexatious problem.

Borderline cases. In addition to the class of patients just mentioned we have the "borderline cases." These patients are men whose hearts are by no means perfect, yet the lesions are of such a nature that careful preoperative attention will make it possible for the patient to undergo operation without running too great a risk. The decision between open operation or intraurethral methods will, under these conditions, require very careful consideration.

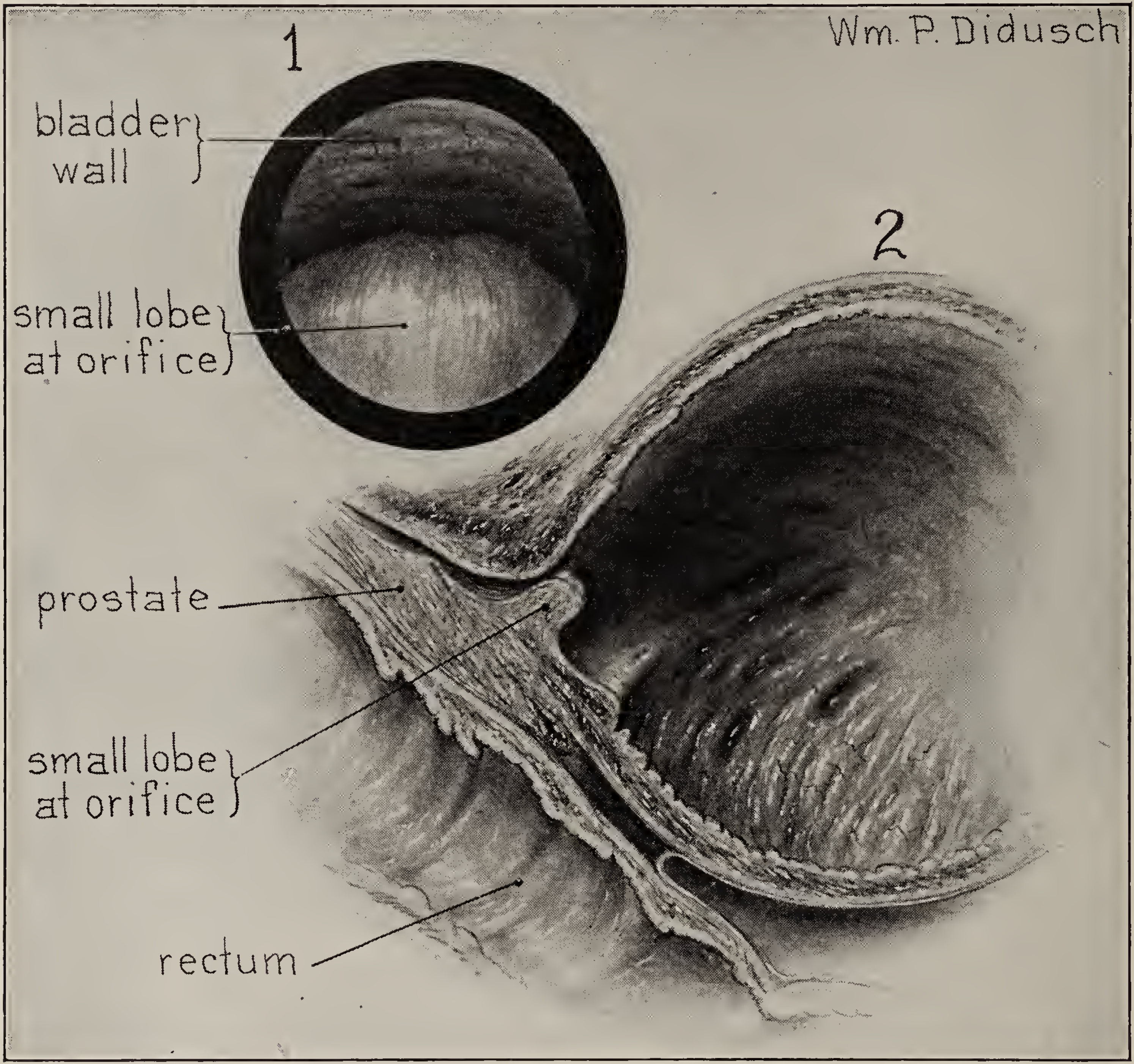

FIG. 20. Slightly enlarged median lobe. (1) Cystoscopic view; (2) Sagittal section showing location of lobe in relation to vesical orifice. (Courtesy of Amer. Journal of Surgery.)

Finally, there is the aged patient, whose general condition is good for his years, but for whom we would use the least shocking methods available. Perhaps no class of subject has been more benefited by intraurethral methods than have these aged but still fairly vigorous subjects of vesical neck obstruction.

Cases suited for electrocauterization. Thus, the legitimate field for electrocauterization by the intraurethral route reveals itself as one of considerable extent, and may be briefly summed up as follows:

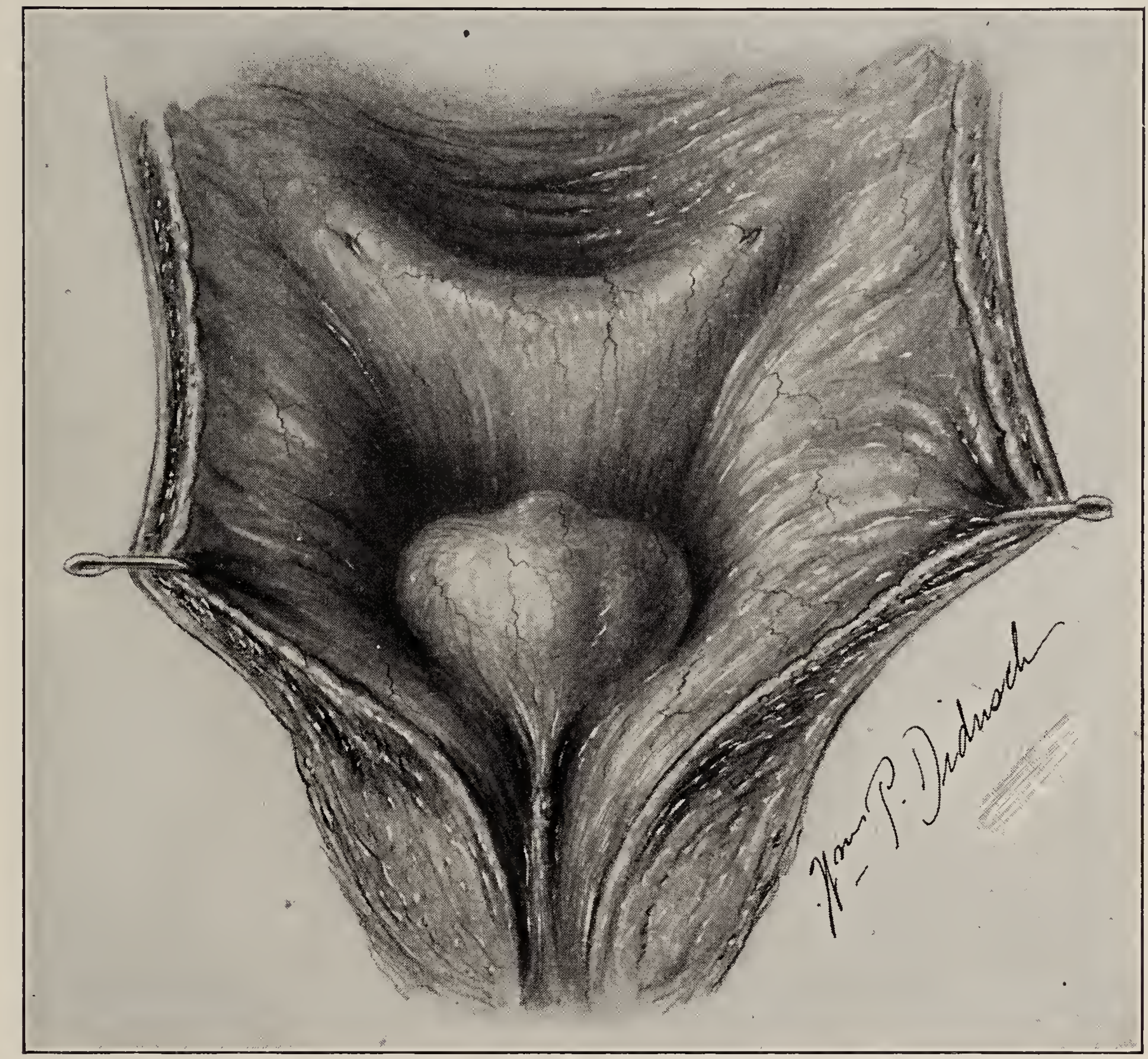

Fig. 21. Moderate enlargement of middle lobe; slight hypertrophy of lateral lobes. Case well suited for intraurethral resection. (Courtesy of Amer. Journal of Surgery.)

Contracted bladder neck.
Median bar obstruction.
Intrusion of large middle lobe, with slight lateral lobe intrusion.
Subcervical gland hypertrophy, causing frequency.
Obstruction due to carcinoma of the prostate.
Congenital valves of the urethra.

Recurrence of prostatic obstruction after enucleation.

In senile or debilitated patients, where a coincident pathology, such as auricular fibrillation, renders even a cystotomy impossible.

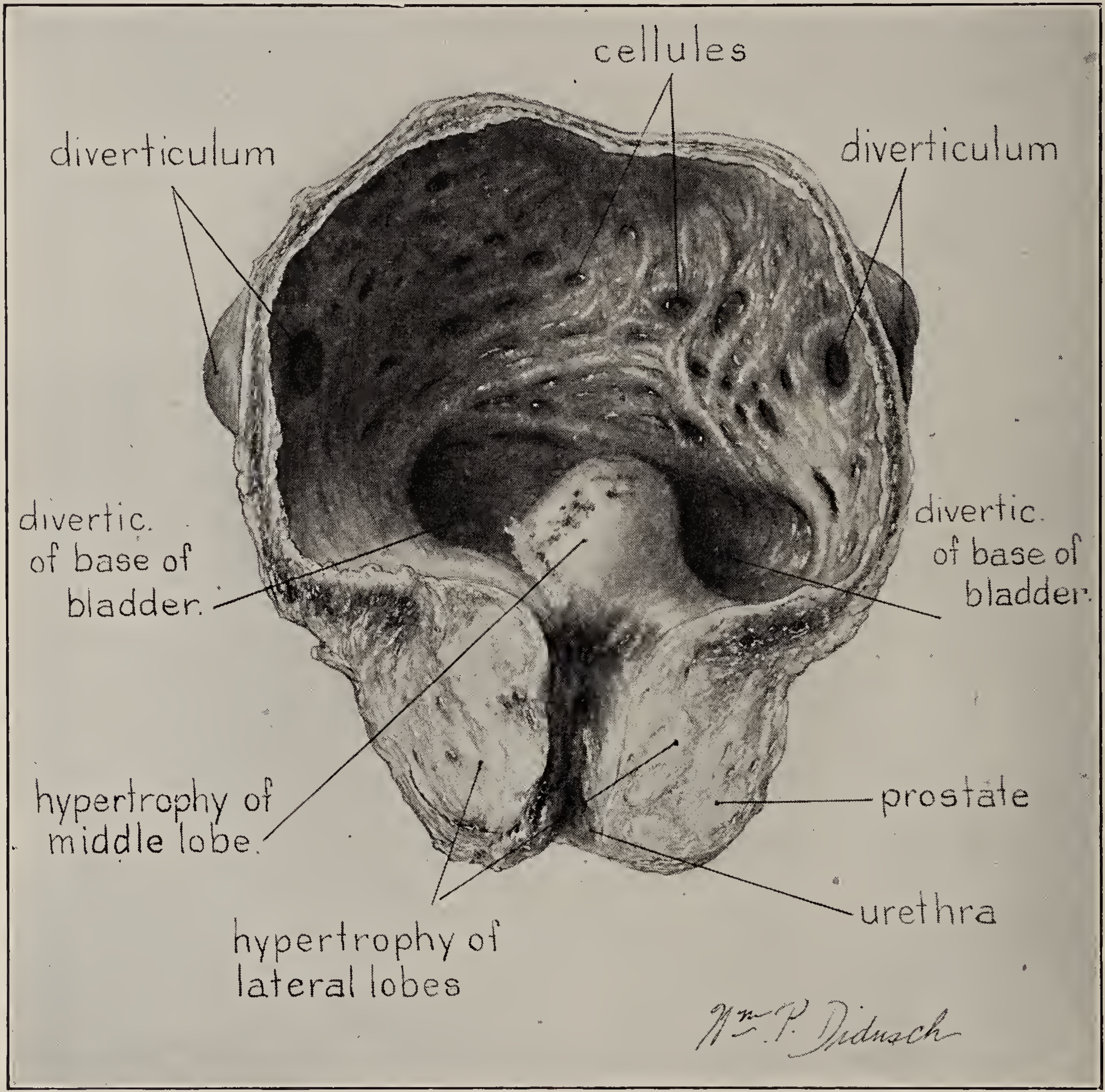
cellules
diverticulum
diverticulum
divertic. of base of bladder.
divertic. of base of bladder.
hypertrophy of middle lobe.
prostate
urethra
hypertrophy of lateral lobes
Wm P. Didusch

FIG. 22. Moderately enlarged middle lobe, with slight enlargement and intraurethral intrusion of lateral lobes. Hypertrophy not yet great enough to prevent satisfactory resection. (Courtesy of Amer. Journal of Surgery.)

In cases where the object is merely to remove enough tissue to establish and maintain drainage.

Especially is the use of this method valuable when a patient is physically incapable of withstanding the usual prostatectomy. How often do we see cases where operation is clearly indicated, and the type of enlargement is such as to lend itself perfectly to enucleation by one of the well-recognized routes; but some complicating condition makes the use of any surgical procedure out of the question, notwithstanding the urgent need for relief of urinary retention if the patient's life is to be preserved.

PATHOLOGY

Types of obstruction at the vesical neck. It is hardly necessary to point out that differentiation between the various types of vesical neck obstruction just mentioned is important, as the treatment desirable in one type will often be inefficient or positively harmful in another. It is requisite, therefore, that any one attempting to relieve a patient suffering from urinary obstruction should acquaint himself with the pathological anatomy of the parts involved and be equipped to make the differential diagnosis without hesitation.

Most important is the differentiation of "median bar enlargement" from that of the true prostatic lobes, or commissural hypertrophy. The posterior commissure is situated entirely within the capsule of the prostate. Therefore, when the tendency to enlarge affects this portion of the prostate, the posterior "lip" of the bladder neck is pushed upward, and this encroachment is resisted by the vesical neck, the muscular structure of which thickens to withstand the pressure. Thus a "bar" is often found in early cases, and the condition is susceptible to the same treatment as is appropriate in what the French call *prostatisme sans prostate*, where the gland — if abnormal at all — is not hypertrophied, but rather small and atrophic.

Inflammatory origin of all bars. All types of bars are clinically similar, probably owing their origin to a previously existant inflammation which brought about cicatricial contraction, with later fibrosis and sclerosis. When the first attempt is made to pass a cystoscope upon one of these patients, the beak of the instrument will encounter an obstruction that proves to be the posterior lip of the vesical orifice rising sharply upward on the urethral aspect. Further investigation will show that on the opposite — that is, the vesical — side it likewise falls off sharply, leaving a ridge directly across the entrance from urethra to bladder, so as to nearly, sometimes completely, obstruct the outflow of urine. Inspection of the bladder beyond this bar will reveal evidence characteristic of urinary retention — hypertrophy of Bell's muscles, trabeculation of the bladder wall, not infrequently the formation of diverticula. Points in the differential cystoscopic diagnosis are: no evidence of the clefting characteristic of enlargement of the lobes of the prostate, together with alteration in the position of the verumontanum, which is pushed almost up to the entrance to the bladder across which the bar has been thrown, a circumstance first noted by Randall almost twenty years ago but not generally recognized by urologists even at the present time.

Pathological changes in the trigone. As all changes which we are accustomed to include under vesical neck obstruction are the after-results of inflammation, if the condition chances to be viewed soon after its inception, the trigone will be in an approximately natural position, although the ureteral ridges will be raised considerably above the normal plane of that portion of the vesical wall. Later the sclerosing process will have lifted the rest of the trigone until a shallow cavity has been hollowed out behind the ridge connecting the two ureteral orifices. As this hollow becomes more pronounced, the trigone juts out above it like a

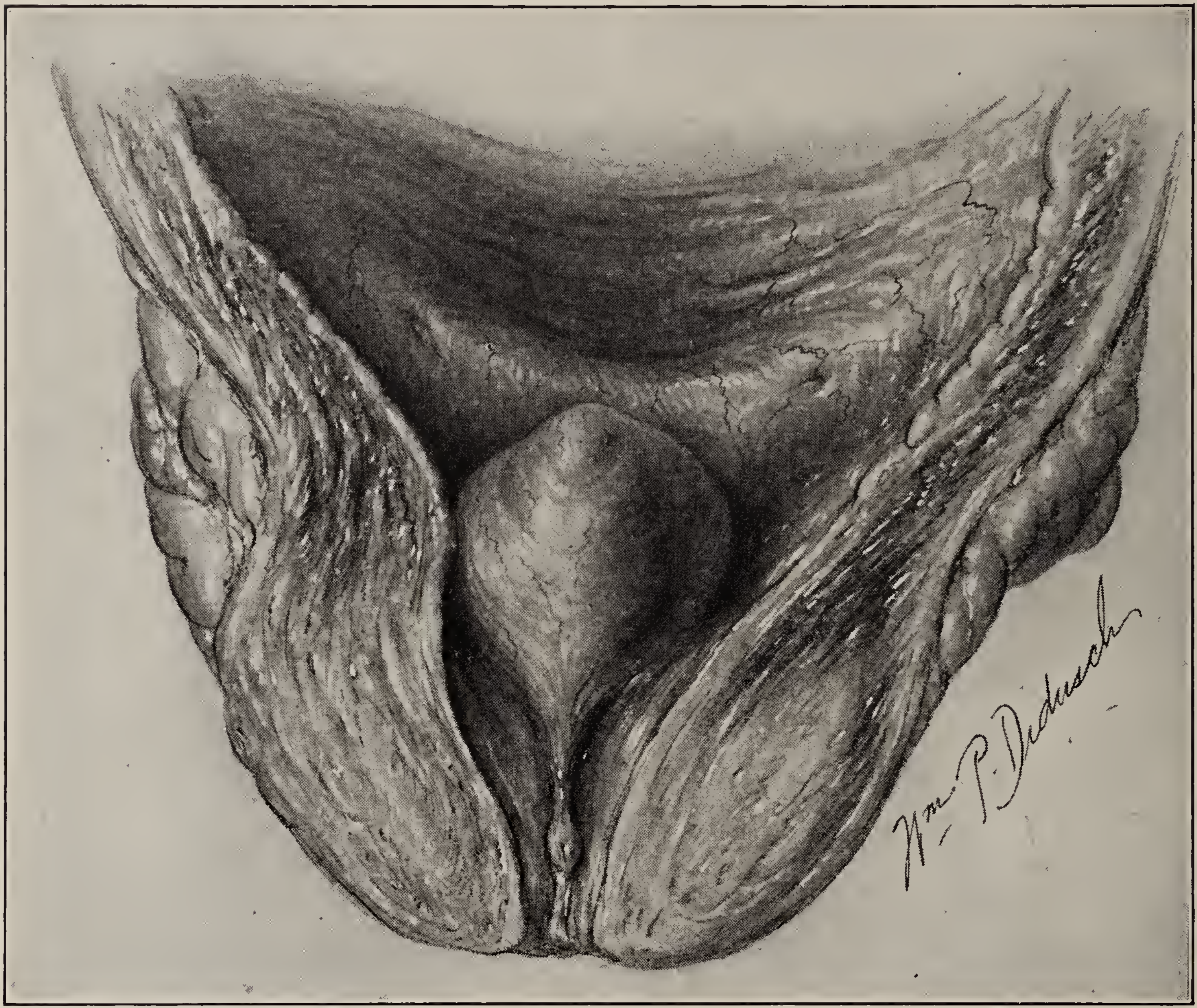

Fig. 23. Moderate hypertrophy of middle lobe, but such marked intraurethral intrusion of lateral lobes as to leave no room for manipulation of the resectoscope. Such cases must be subjected to prostatectomy. (Courtesy of Amer. Journal of Surgery.)

shelf, and eventually, in cases seen when far advanced, the indentation will be so much increased in size that it undermines the trigonal muscle, "dissecting" it free and forming a partial septum so that the cavity of the bladder is partitioned off into two sections.

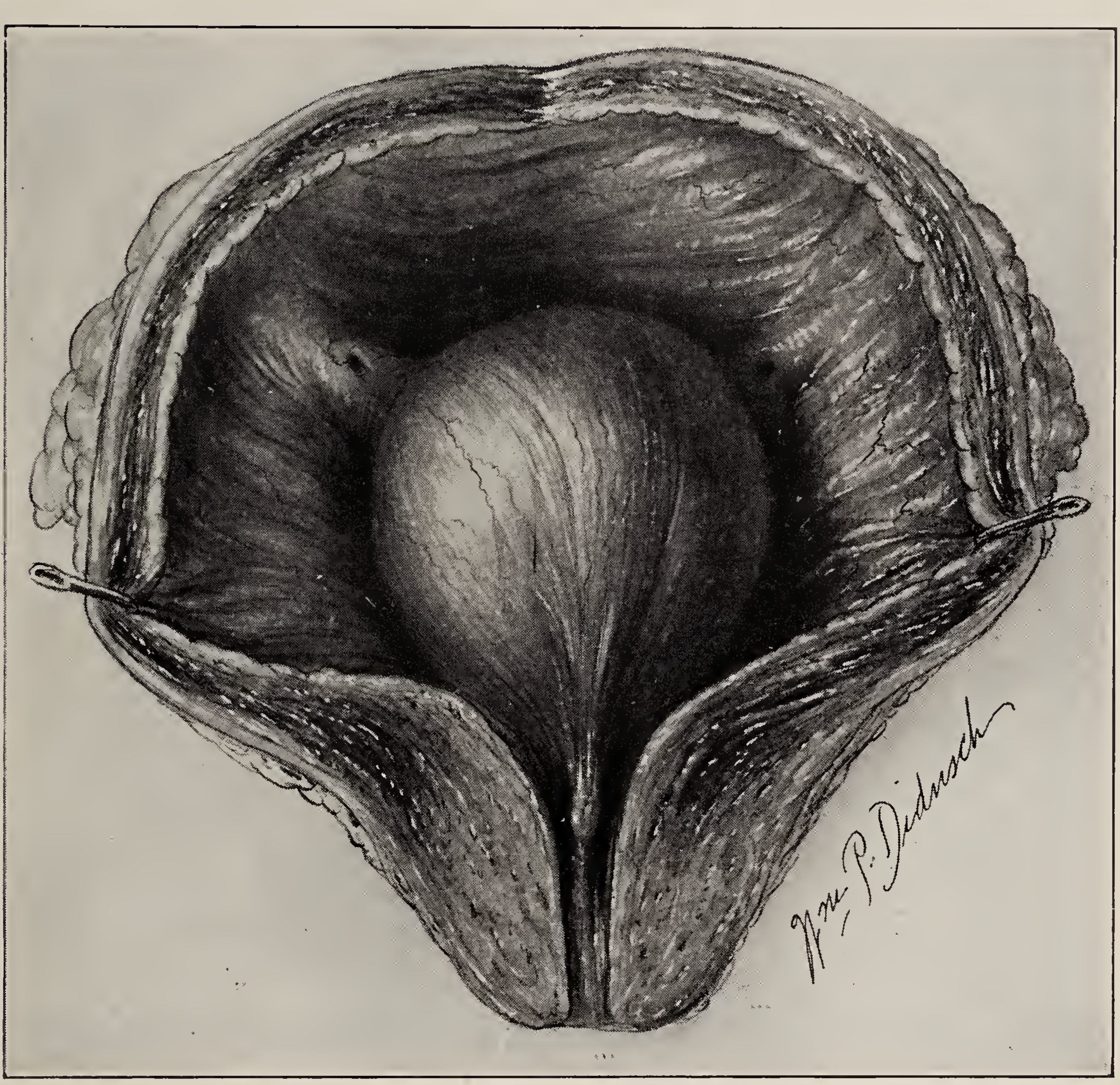

Fig. 24. Great enlargement of middle lobe, accompanied by considerable hypertrophy of lateral lobes; the resulting mass of tissue is too great to be handled successfully by the intraurethral method. (Courtesy of Amer. Journal of Surgery.)

Three forms of "prostatic hypertrophy." Until recently, clinicians were content to designate as "prostatic hypertrophy" almost any obstruction at the vesical neck, but it is now recognized that there are three distinct pathologic entities which may bring about like conditions of urinary retention because of increase of tissue about the outlet of the bladder. These are (1) hypertrophy of any or all of the lobes included within the prostatic capsule; (2) hypertrophy of the subcervical glands of Albarran, which lie entirely outside the capsule; and (3) thickening and contracture of the vesical neck, with displacement of the trigone and formation of " median bar."

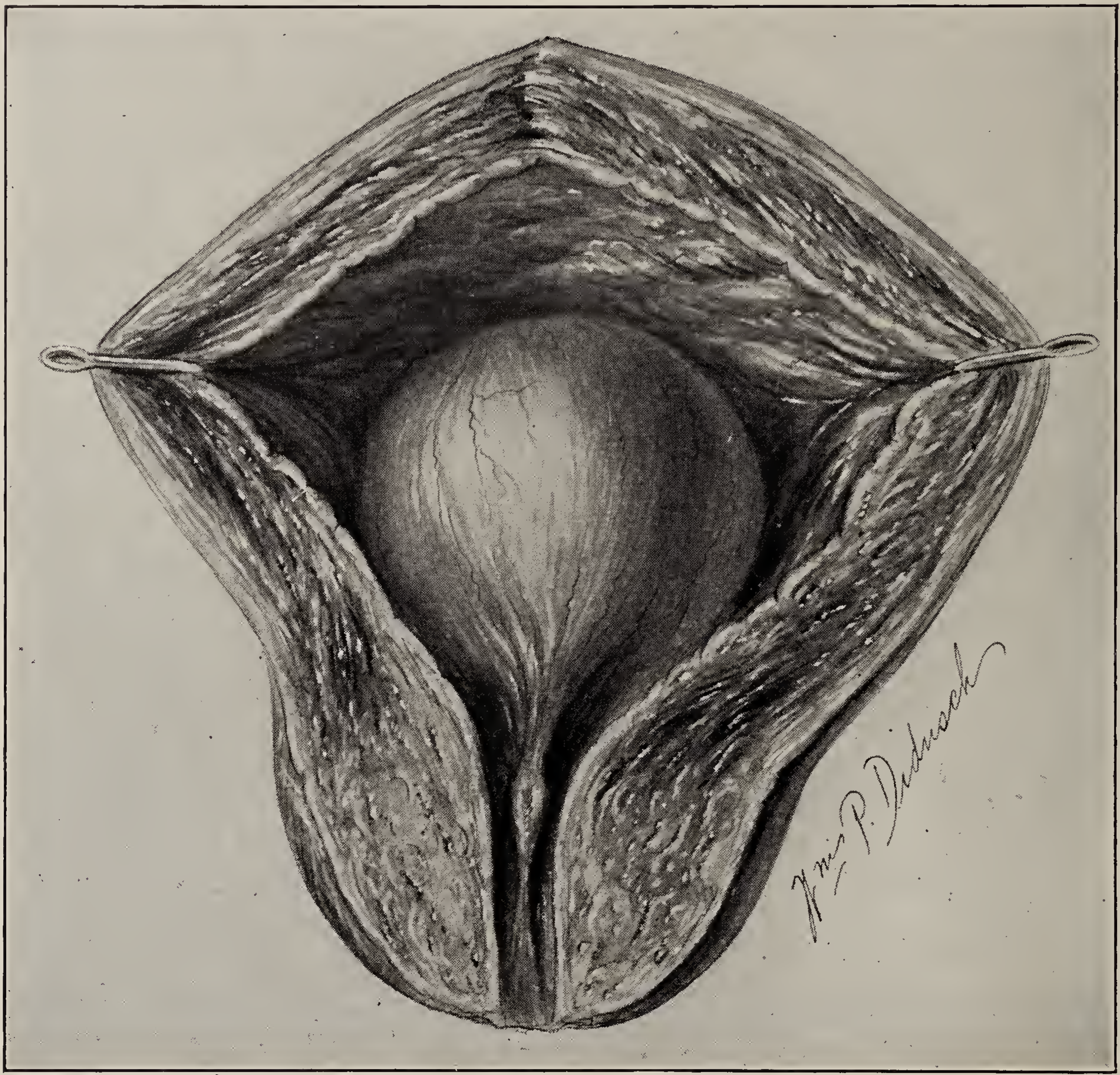

FIG. 25. Tremendous hypertrophy of middle lobe, with marked intraurethral enlargement of both lateral lobes. Prostatectomy is the procedure of choice for all such conditions. (Courtesy of Amer. Journal of Surgery.)

With a better understanding of the differences between these varied forms of prostatic and vesical neck pathology has come the realization that our mode of treatment must be varied to meet the peculiar demands of each type. We can no longer proceed to remove the prostate by that certain prescribed route which the surgeon's experience has taught him to follow with the greatest facility. It is incumbent upon each operator, who desires to intervene upon a case of urinary obstruction, not only to ascertain exactly what *type* of barrier he has to deal with but also by what means he can best relieve it, after careful consideration of all the factors involved and a most exhaustive examination of his patient's entire economy — even political.

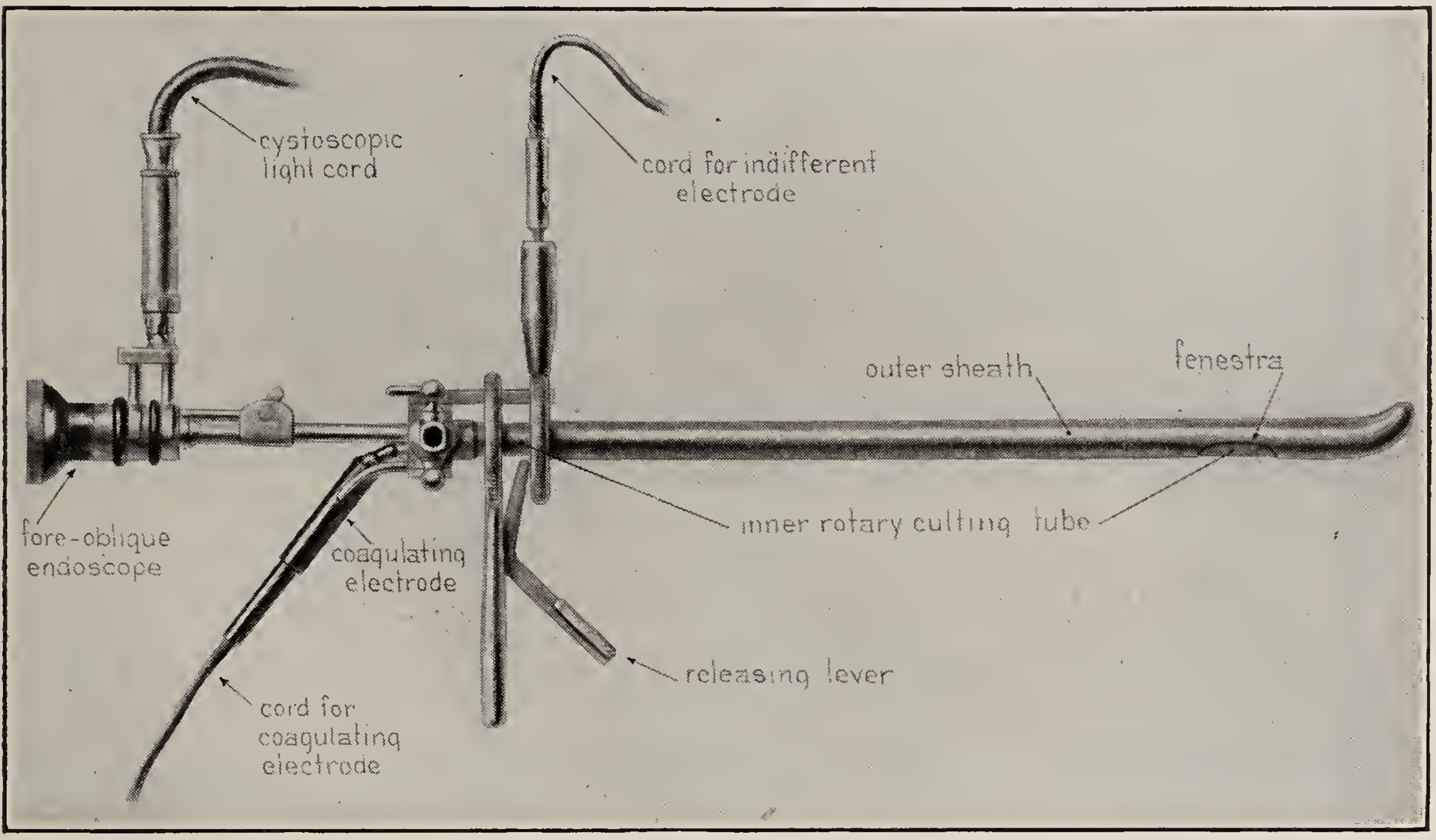

Fig. 26. Kirwin vesical neck resector, showing instrument assembled. (Courtesy Surg., Gynec., & Obst.)

TREATMENT

Choice of method. The previous discussion has plainly shown that no one method is capable of dealing with all types of vesical neck obstruction. In fact, success has come to depend upon the good judgment of the surgeon in selecting the curative procedure which is best fitted to the peculiar needs of the individual patient. The day when a surgeon could routinely do a "suprapubic" or a "perineal," and be considered a competent operator, whether his patient lived or died, has forever passed away. There are now so many routes possible that the operator's responsibility is vastly increased, but increased also are his chances of complete success in what was once among the most hazardous of urologic procedures.

Relief of urinary retention. Temporary relief of urinary obstruction has for some time been obtained by the classic suprapubic cystotomy, by use of the indwelling catheter, or recently, in selected cases, by the suprapubic incisor designed by Mr. Frank Kidd, of London. Of late, these procedures tend to be abandoned in favor of immediate intraurethral excision by cautery or otherwise. The types of cases suited for such treatment have already been indicated. Concerning the relief of "prostatism" by punching, tunnelling, or excising the hypertrophied lobe or lobes, or cutting out the fibrous tissue forming a barrier at the vesical outlet, much remains to be said. Most of the instruments, specially designed to facilitate operations of this nature, are still in the experimental stage, while the medical profession is as yet by no means agreed as to the relative merits of open operation or intraurethral methods. I can do no more, therefore, than describe my own endeavors along this line, and draw upon the experience of colleagues who have reported their results upon similar material, leaving the reader to draw his own conclusions.

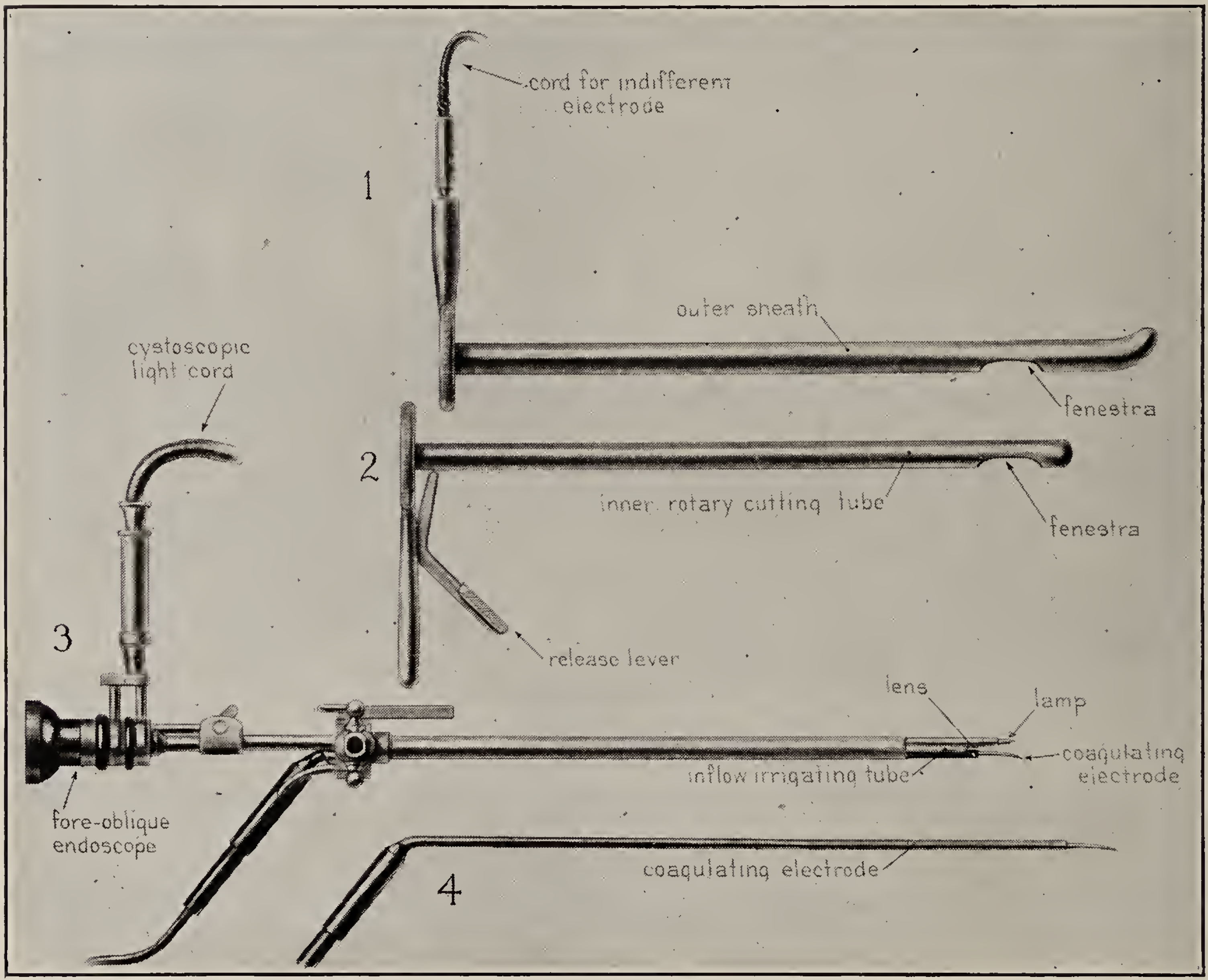

FIG. 27. Kirwin vesical neck resector; instrument dismounted, showing component parts and electrical connections. (Courtesy Surg., Gynec., & Obst.)

Obstruction due to hypertrophy of the median lobe, including posterior commissural enlargement, as well as that of the subcervical lobes of Albarran, can be relieved by intraurethral operation, *provided that the hypertrophy has not reached large dimensions.* This last phrase is italicized because of its great importance. If there is fibrosis of the collar type, or sclerosis due to atrophy, excision through the cystoscope or intraurethral coagulation will prove more satisfactory than open operation. When the obstruction is seated in the bladder neck, or in the supramontane portion of the posterior urethra, the hypertrophied tissue takes up so much room that a clear view by cystoscope, or any lens device, is out of the question. Equally impossible is the use of an electrocautery method,

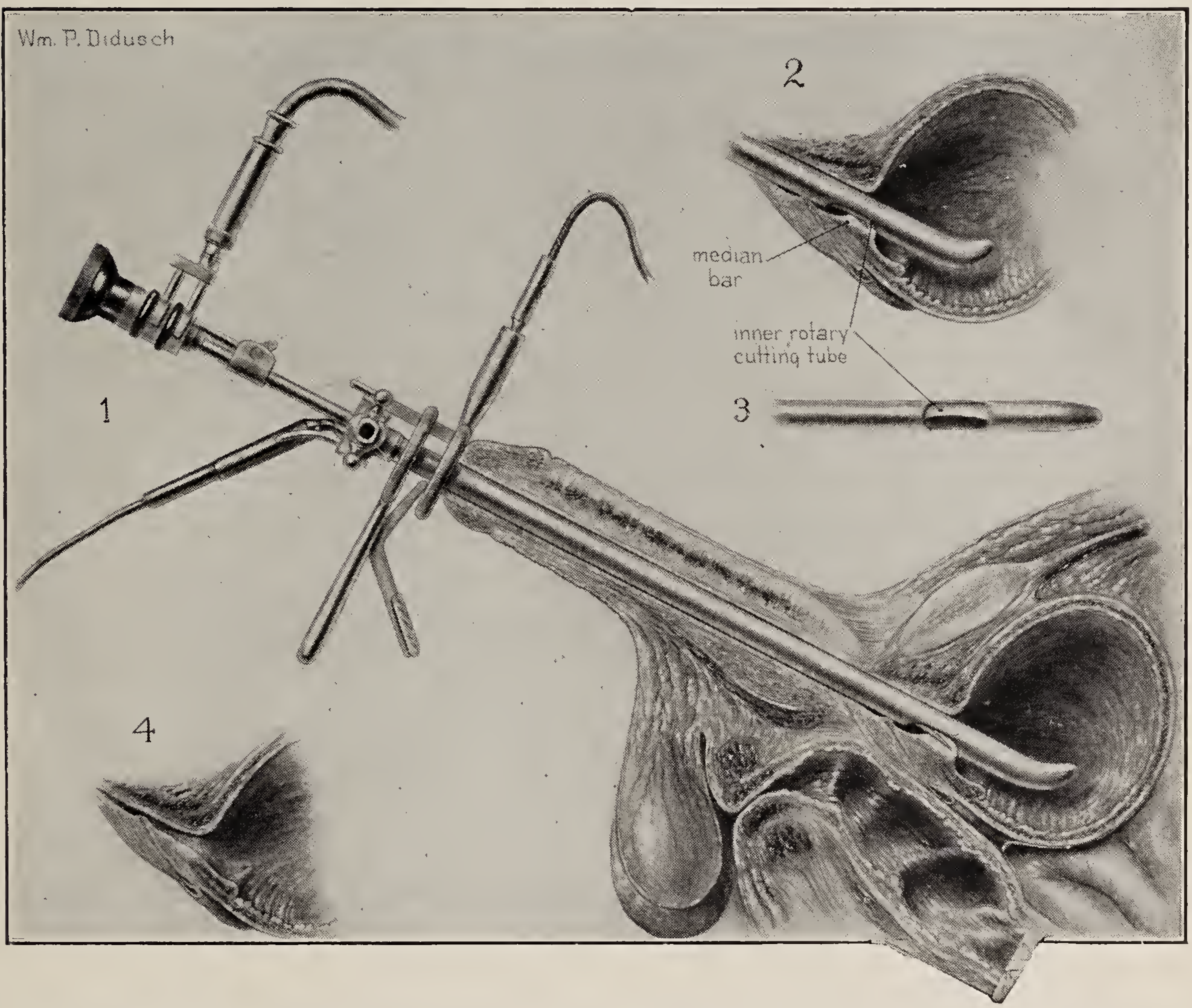

FIG. 28. Kirwin vesical neck resector in position for use. 1. Sheath passed through urethra into bladder; cautery needle point fixes tissue to be removed. 2. Tissue has been desiccated (indicated by blanching) and is about to be cut off by 3. The inner rotary cutting tube. (Courtesy Surg., Gynec., & Obst.)

because the marked enlargement of the gland and the consequent lengthening of the urethra make punch or resectoscope useless.

Preoperative attention. In general, the preoperative preparation of patients should be given as much attention as when the most extensive prostatectomy is contemplated. Renal, cardiac, or other complications must be dealt with in a thorough manner. It is also important to make the urethra tolerant of instrumentation, as it would be, of course, impossible to do a successful intraurethral intervention upon one who found it difficult or impossible to permit instrumentation or proved actively inimical of such procedures by the setting up of an acute infection. If sufficient time is allowed before the intervention, most of these difficulties can be overcome. I have found spinal anesthesia by the method of Labat to be the best form of analgesia, but the experienced cystoscopist — and no other should think of doing intraurethral operative work — will have his own pet means of relieving his patient of pain. Any form of inhalation anesthesia is to be avoided, as the dangers of hemorrhage are thereby greatly increased. The administration of preliminary narcosis, commonly scopolamine and morphine, is considered essential by the majority of operators, but can often be dispensed with, without imposing any greater suffering upon the patient.

AUTHOR'S VESICAL NECK RESECTOR

After making use for some time of various instruments designed to remove obstructions at the vesical neck, the author gradually evolved one of his own, which he has found to fulfil the needs of the surgeon more completely than any he has seen or used. It differs from kindred devices mainly in that it is *rotary*, and thus inevitably follows the normal contour of the bladder neck while cutting, and in the possibility of regulating the heat provided by the cautery, so as to keep it below the temperature injurious to tissues adjacent to those which are to be resected. The instrument has a sheath, a telescope, a lamp, a needle electrode, and an irrigating system, yet the rotation of the knife is independent of them all. An inner tubular structure replaces the usual obturator, and between this and the outer sheath a tubular knife rotates to the operator's right, thus opening the fenestra. Despite independent rotation of the knife, the main instrument has the freedom of motion necessary for exact location of the tissues to be excised, the site of which the preceding cystoscopic examination has determined.

Importance of low heat. The nature and situation of the obstructing tissue having been ascertained, it is engaged in the fenestra and im-

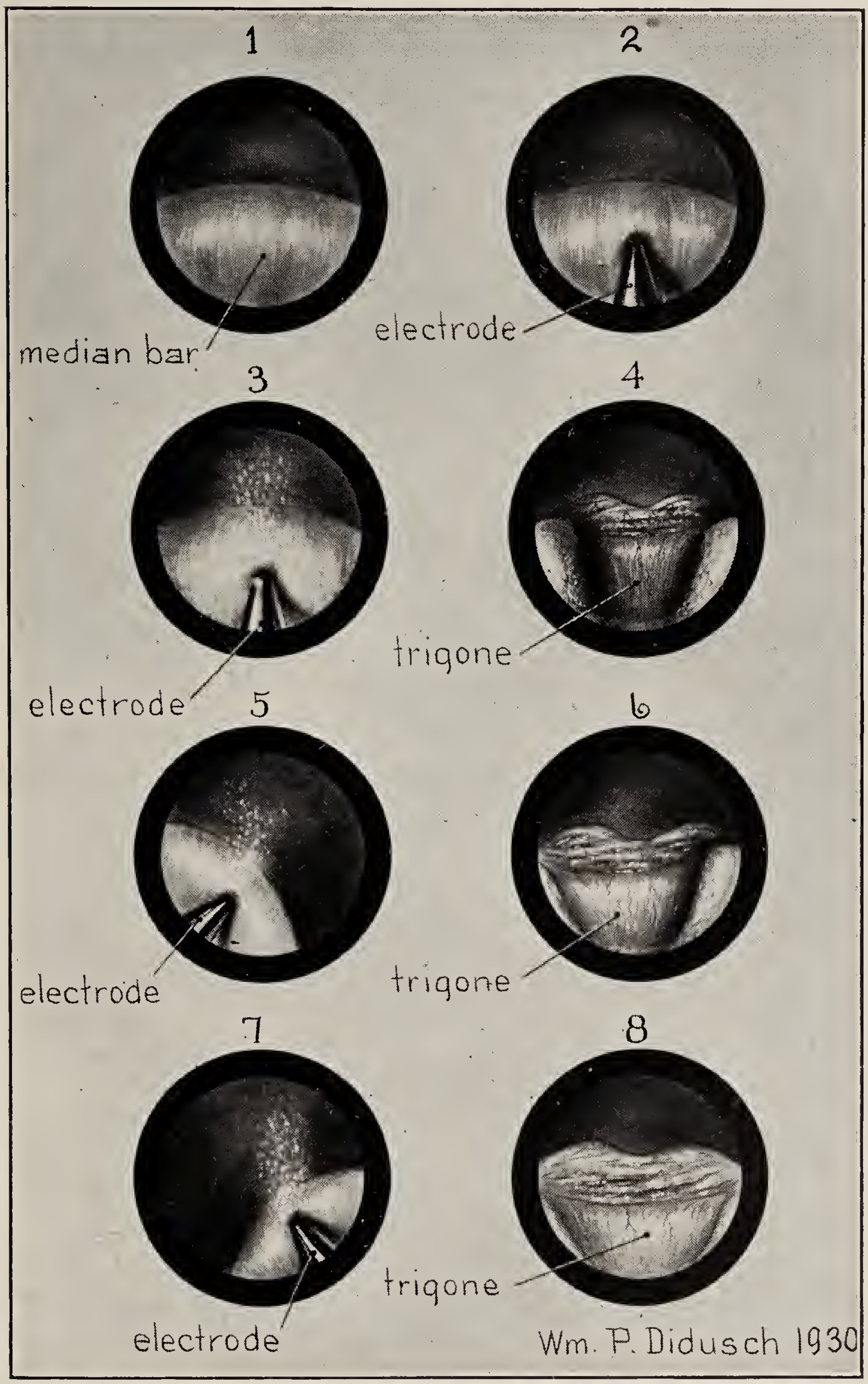

FIG. 29. Resection of vesical neck obstruction. 1. Median bar of dense sclerotic tissue. 2. Needle electrode applied to center of bar. 3. Desiccation of tissue (indicated by blanching). 4. Trigone exposed by first excision. 5. Needle electrode applied at one side of bar. 6. Further exposure of trigone. 7. Needle electrode applied to opposite side of bar. 8. Trigone in full view after three cuts have been made with rotary cutting blade following desiccation of tissue. (Courtesy Surg., Gynec., & Obst.)

paled by the needle electrode, which keeps it from slipping from the fenestra at the same time that it coagulates the vessels, thus preventing hemorrhage as they are severed by the rotary knife. With the needle electrode in place, they are desiccated at low heat for about 30 seconds.

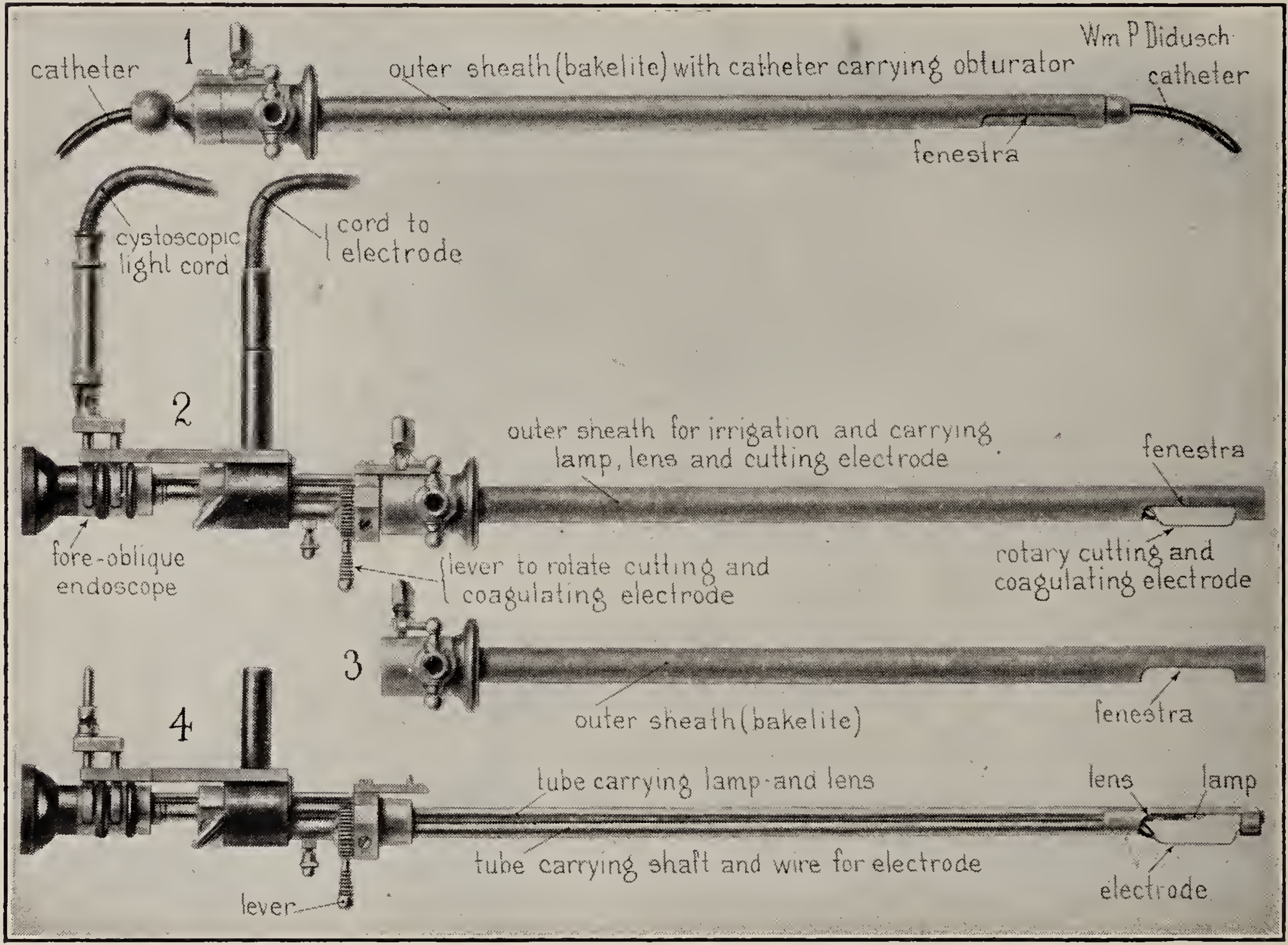
Wm P Didusch
1
catheter
outer sheath (bakelite) with catheter carrying obturator
catheter
fenestra
cystoscopic light cord
cord to electrode
2
outer sheath for irrigation and carrying lamp, lens and cutting electrode
fenestra
fore-oblique endoscope
lever to rotate cutting and coagulating electrode
rotary cutting and coagulating electrode
3
outer sheath (bakelite)
fenestra
4
tube carrying lamp and lens
lens
lamp
tube carrying shaft and wire for electrode
electrode
lever

FIG. 30. Kirwin rotary prostatic resectoscope. 1. Outer bakelite sheath with obturator in place. The catheter carrying obturator is to be used when difficulty in introducing instrument is encountered. 2. Instrument assembled; foroblique endoscope; bakelite sheath; lamp, lens and cutting and coagulating electrode. Electrode consists of a wire, which is rotated by means of a lever attached to a shaft. 3. Outer sheath showing fenestra; irrigation is carried out through this shaft and around the tube carrying lens, light and electrode. 4. Foroblique endoscope and the tubes carrying lens, light, and cutting and coagulating electrode. (Courtesy of Amer. Journal of Surgery.)

The knife is then rotated, excising the section within the fenestra, which can then be immediately removed.

The foroblique lens system of McCarthy permits every step of the procedure to be carried out under full vision, and the efficient system of cauterization keeps the field practically clear of blood. When the tissue is engaged in the fenestra and the current turned on, the tissue is traversed by the current emanating from the needle electrode. It is evident that, no matter whether one employs a single needle or several at once, the effect of the current must be active for a considerable distance from its point of insertion, and that it would be quite impossible to concen-

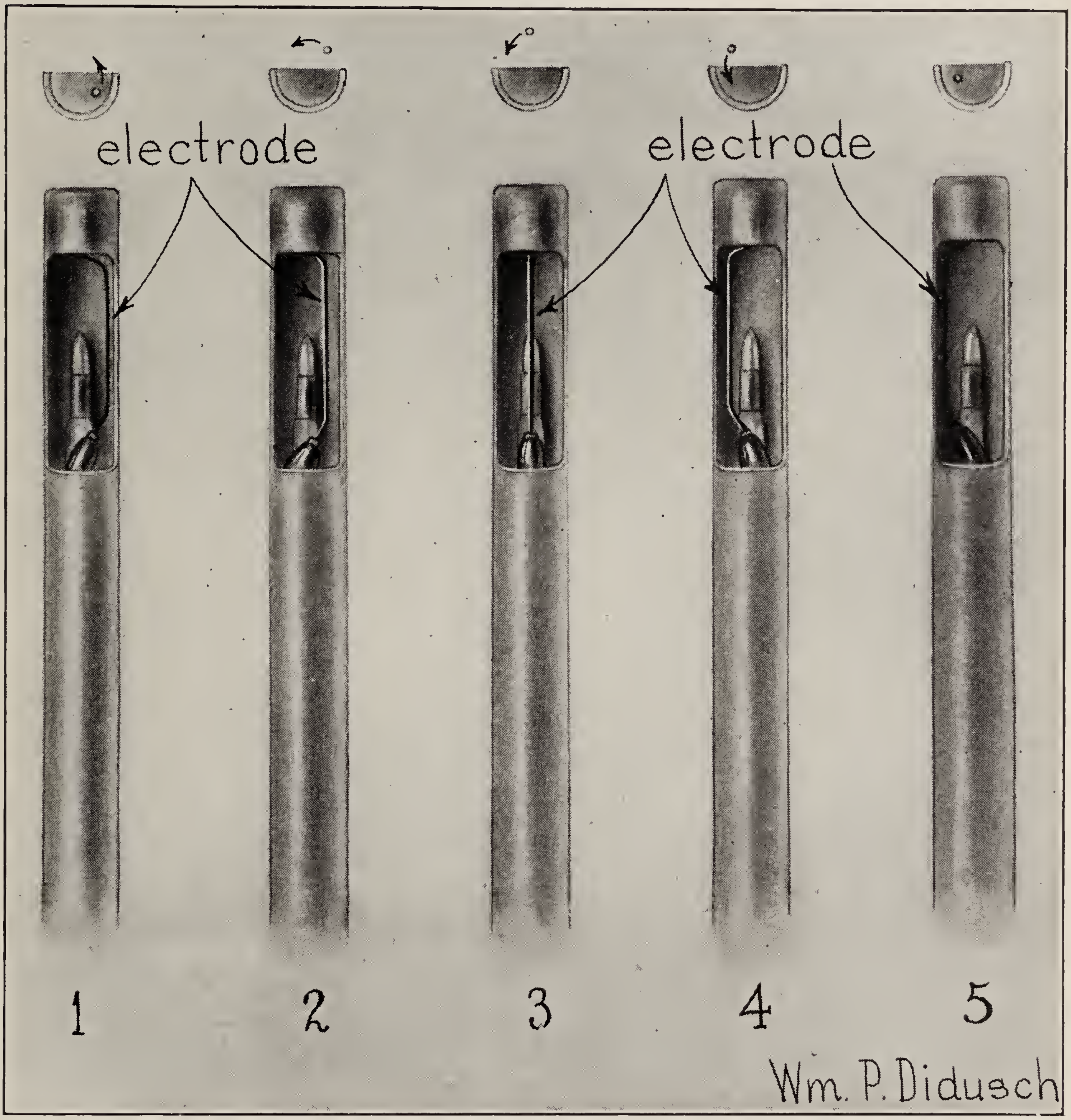

FIG. 31. Kirwin rotary prostatic resectoscope. Detail, showing mechanics of cutting electrode. Instrument is viewed from under-surface, looking into fenestra (above, sectional views of instrument to show position of wire; wire shown moving from left to right.) Note in No. 3 wire is directly in midline and changing caliber of instrument from 28–French to 32–French. This enables a larger piece of tissue to be removed. (Courtesy of Amer. Journal of Surgery.)

trate all its effects at a minute point so that one could excise at a single "bite" every particle affected by the coagulating current.

The outer sheath remains undisturbed in the urethra throughout. Rotation of the inner sheath during withdrawal prevents jerking and consequent trauma. The knife and tube can be withdrawn and reinserted as many times as is necessary to resect and remove the obstructing tissue. The electric needle and the sharp knife edge serve to engage the instrument firmly in the tissue, so that it is actually possible to get larger sections than with other instruments of this type. The lateral position of the knife makes possible the cutting of larger sections. The fenestra differs from any previously designed in that all sharp edges and protuberances have been done away with, permitting free motion while searching for the vesical neck obstruction, without any danger to adjacent tissues.

THE ROTARY PROSTATIC RESECTOSCOPE

With the introduction of the new high frequency cutting current, the author was able to design another instrument embodying the particular advantages of that just described but capable of taking much larger resections, adapting it for work upon the hypertrophied prostate and in other situations demanding large resections of tissue. The retention of the rotary principle, the employment of cutting current, and the perfect visualization of every step of the procedure, make this latest instrument a most efficient addition to intraurethral surgery. But, as it can only be employed in connection with the McCarthy surgical unit, whereas the vesical neck resector can be used with any ordinary diathemic apparatus, the expense of its complete equipment is considerably greater than that of the vesical neck resector. The earlier instrument remains, however, such a simple, efficient, and "foolproof" design for employment in the routine of general surgical practice, that it is still unrivaled in its particular field of dealing with bars, contracted bladder neck, and small median lobes.

In the rotary prostatic resectoscope a wire electrode, working by a lever, simultaneously resects tissue and closes up severed vessels. Its rotary motion definitely follows the contour of the bladder neck, leaving behind it a smooth, cone-shaped orifice. Any bleeding point can usually be controlled by pressure upon the sheath. By turning on irrigation, the field is then cleared and the electrode slowly rotated so as to pass over the bleeding point and effect proper coagulation.

A strong point in favor of this design is the fact that a small-caliber instrument — 24 French, for example — when rotated, extends up to 28

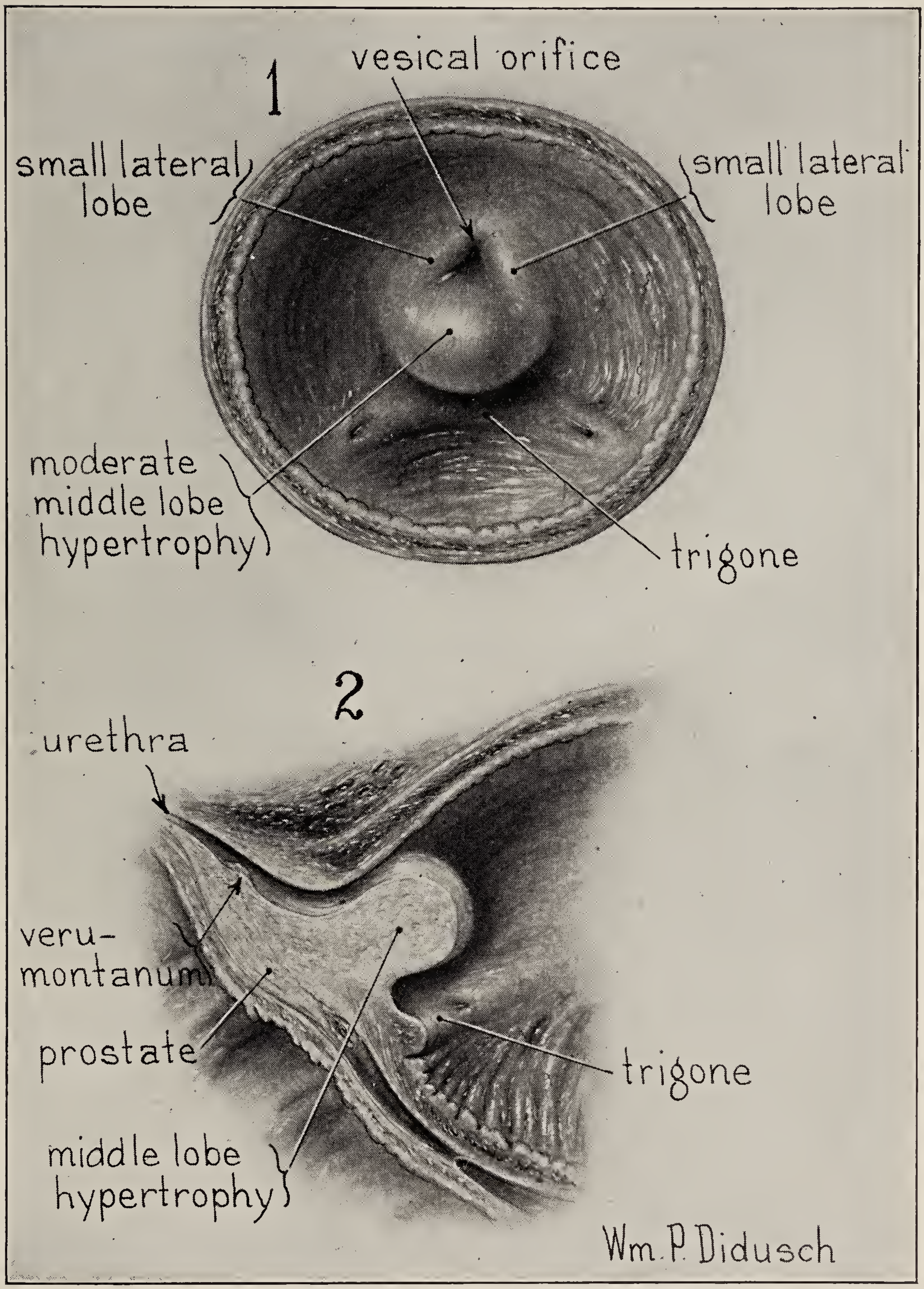

Fig. 32. Typical case suitable for resection. 1. Vesical orifice viewed from within the bladder; lateral lobes but slightly enlarged; middle lobe hypertrophy of moderate degree. 2. Sagittal section at vesical orifice, middle lobe hypertrophy in evidence; verumontanum visible in section. (Courtesy of Amer. Journal of Surgery.)

French in its eccentric swing. This permits the taking of much larger bites, and, if the urethra chances to be unusually narrow, any chance of trauma is avoided. An extensive excision may be carried out, or one may merely remove enough tissue to permit drainage. The instrument is equally effective in either event. Spinal anesthesia by Labat's method is used in this procedure also, but should the facilities for administering it be lacking, novocaine may be injected directly into the site of operation.

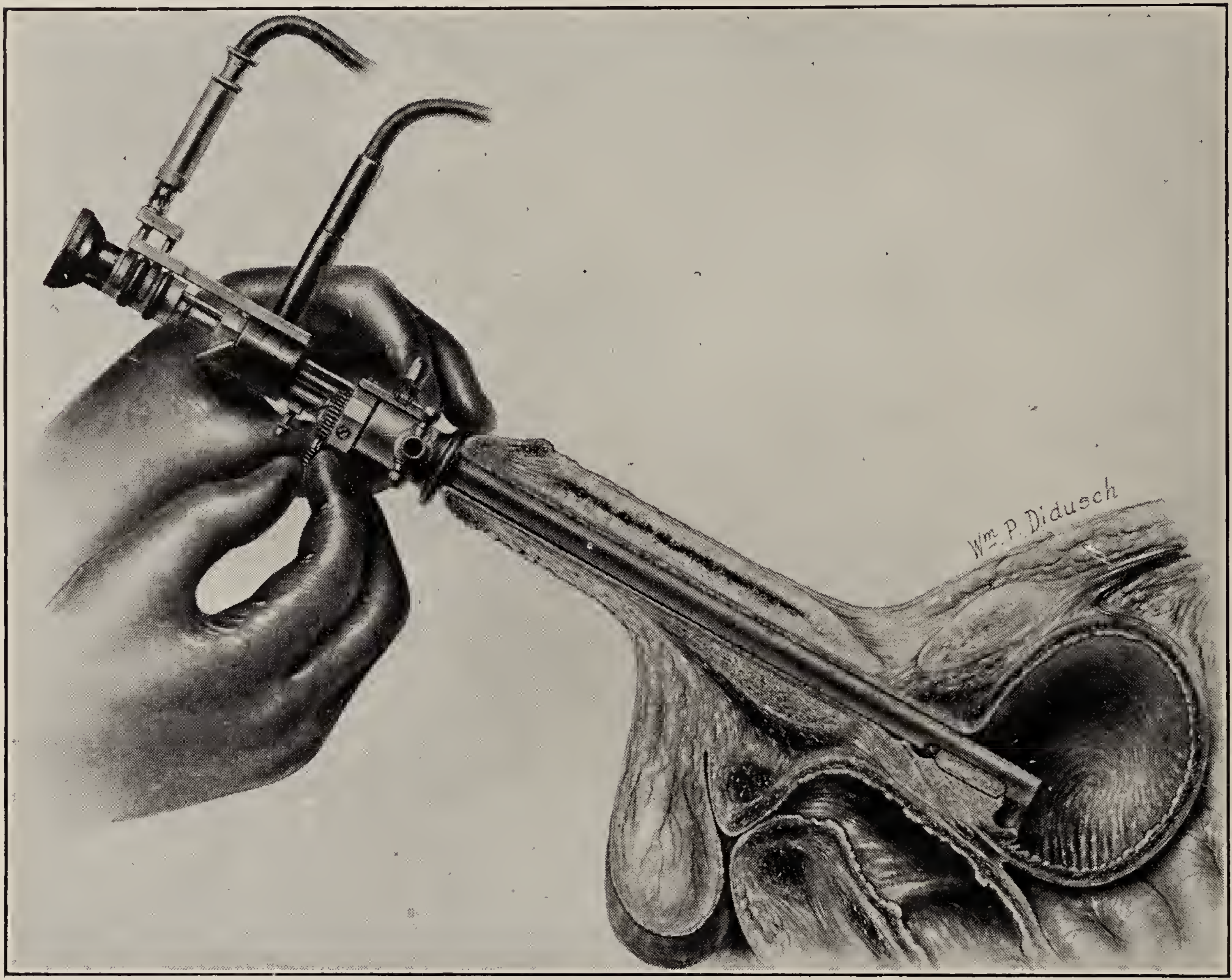

FIG. 33. Sectional view showing rotary prostatic resectoscope in position. Middle lobe engaged in fenestra and electrode removing tissue. Operator's left hand holds instrument in position — shaft being greatly elevated while resection of middle lobe is being carried out. Right hand grasps lever and slowly rotates it, thereby imparting a rotary motion to electrode resecting middle lobe. (Courtesy of Amer. Journal of Surgery.)

After-care. Though a once formidable intervention is now reduced to a minor procedure, it must not be supposed that the after-care is any less important. Immediately after the resection is finished, a No. 20 or 22 soft-rubber catheter should be passed through the urethra and permitted to remain undisturbed for 24 to 48 hours. There should be regular dilatation of the posterior urethra and bladder for a number of weeks after healing is complete, and the patient must be required to report regularly for inspection until there is nothing abnormal to be seen on cystoscopic examination.

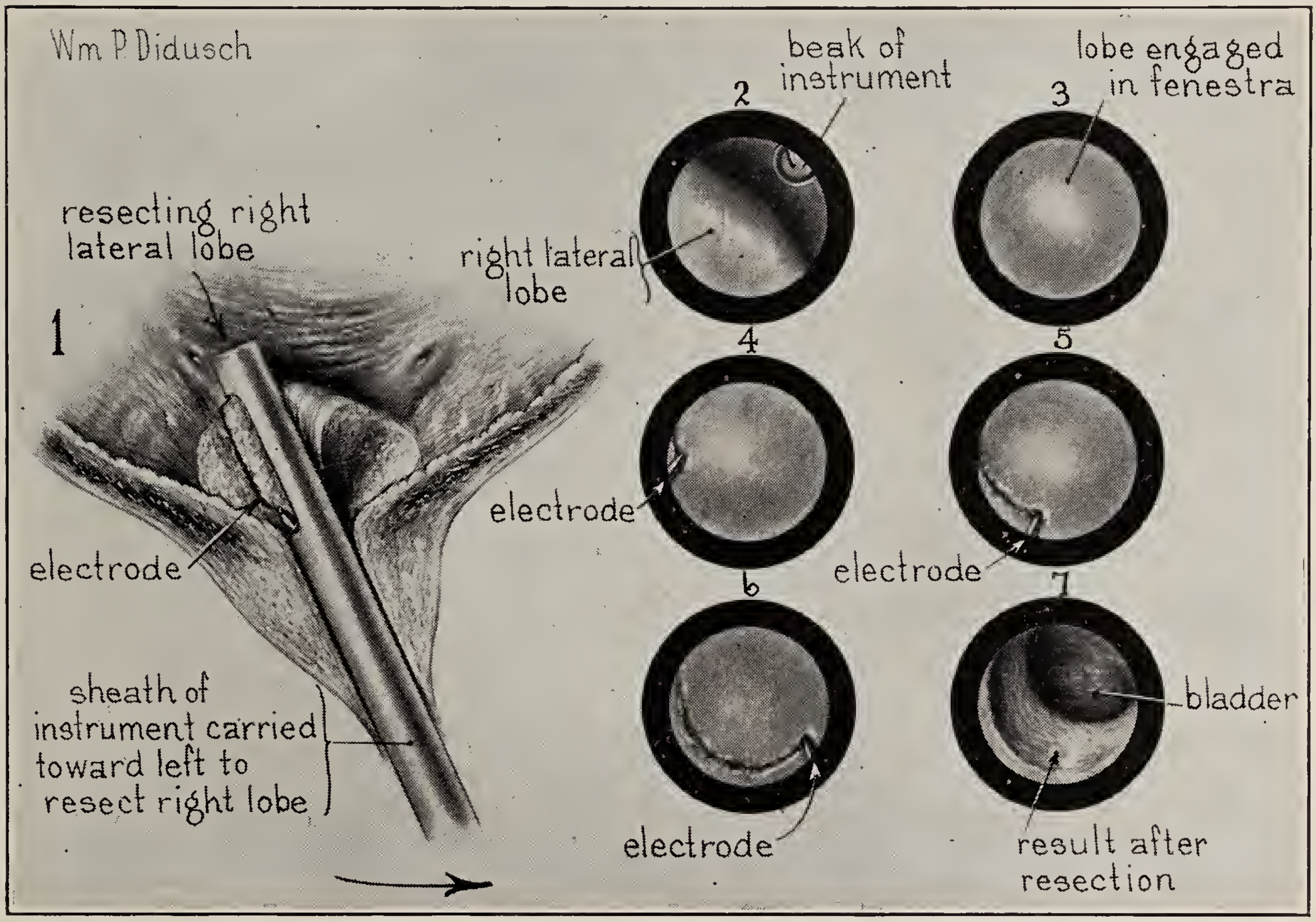

FIG. 34. Resection of right lateral lobe. 1. View of bladder and vesical orifice. Shaft of instrument carried well to left side of patient while resecting right side of vesical orifice. Wire electrode seen removing portion of right lateral lobe. 2. Cystoscopic view, right side resection; right lateral lobe and beak of instrument shown. 3. Lobe engaged in fenestra, in position to resect. Note that beak of instrument cannot be seen, showing that lobe is well within fenestra. 4. Electrode begins to cut through prostatic tissue (beginning of arc) from left to right. 5. Further movement of electrode through tissue. 6. Electrode about to complete cut. 7. View of cut, showing final result, a large groove through prostate. (Courtesy of Amer. Journal of Surgery.)

Frequency of prostatic malignancy. Regular pathologic examination of the resected tissue should never be omitted. On an average, the ages of patients presenting median bar obstruction and contracture of the bladder neck are somewhat lower than those of sufferers from benign prostatic hypertrophy or carcinoma of the prostate. That malignancy of this gland is far more common than we have heretofore supposed has been revealed by statistics recently compiled. Of male deaths from cancer, 4 per cent. are due to prostatic malignancy. During 1927, of 1,237,000 deaths from all causes in the United States, 4,300 were due to cancer of the prostate. There is no doubt that many cases of prostatic malignancy are overlooked, and we know that many more are recognized only when rapid metastasis to other parts of the body has called attention to the primary focus. Therefore, no matter what the age of a patient suffering from obstruction at the vesical neck may be, his physician should not rest until he has positively eliminated malignancy, or has recognized and dealt with it.

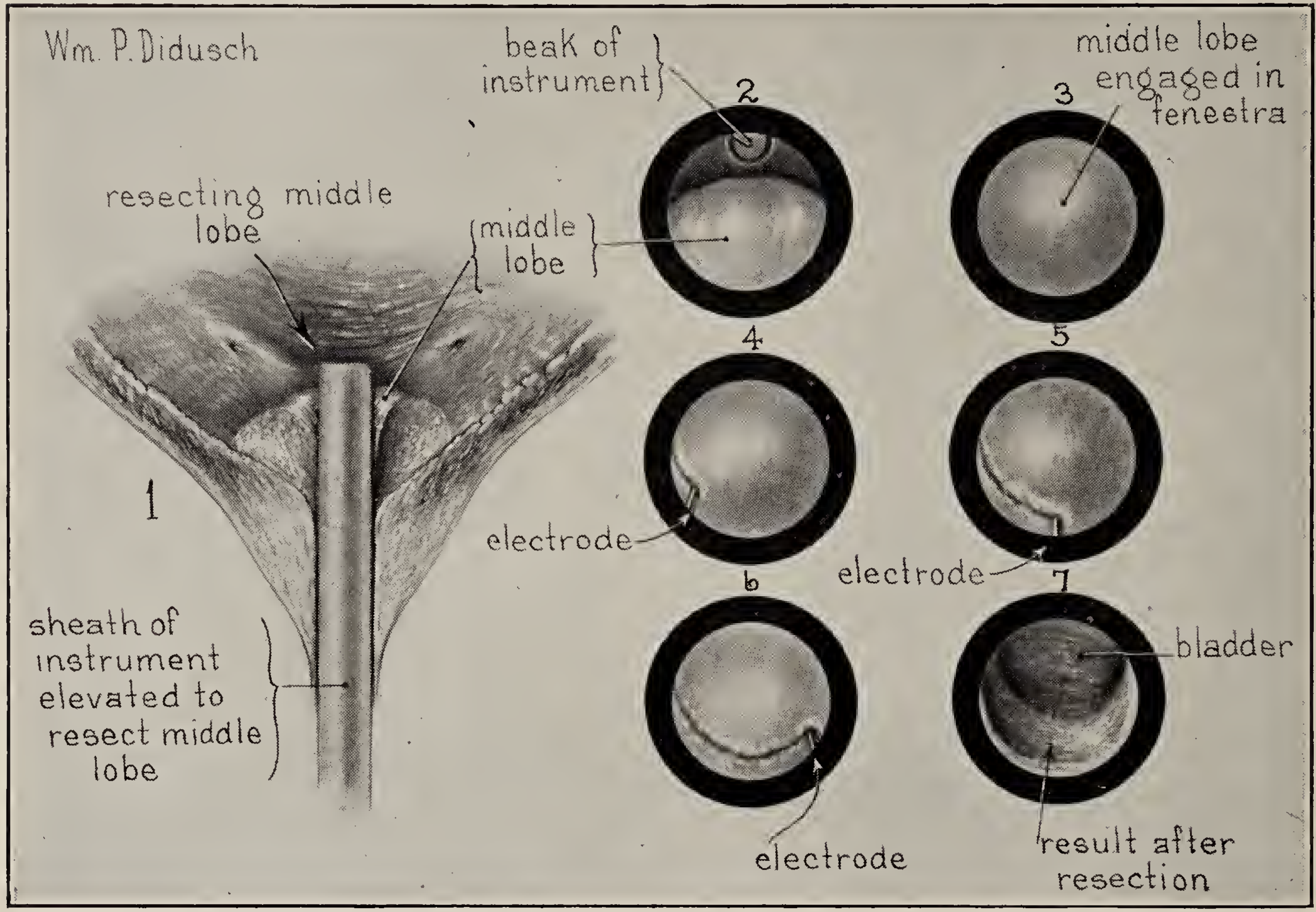

FIG. 35. Resecting middle lobe of prostate. 1. Bladder at vesical orifice; cutting electrode downward and invisible. In resecting posterior or middle portion of vesical orifice, shaft of instrument must be greatly elevated so as to engage tissue in fenestra. 2. Cystoscopic view of resection of middle lobe, showing beak of instrument. 3. Lobe engaged in fenestra, ready to be resected. Beak of instrument invisible, proving that lobe is well within fenestra. 3. Lobe engaged in fenestra ready to be resected; note that beak of instrument cannot be seen, proving that lobe is well within fenestra. 4. Electrode begins to cut through prostatic tissue (beginning of arc) from left to right. 6. Electrode about to complete cut. 7. View of result after cut has been made, showing bladder and large groove through prostate. (Courtesy of Amer. Journal of Surgery.)

Employment of the resectoscope in prostatic carcinoma. When routine preliminary examination of a case of urinary retention reveals the stony hardness of the prostate, on rectal palpation, which is so peculiarly characteristic of malignancy of that gland, recourse should at once be had to biopsy. A specimen may be secured through the cystoscope before any attempt is made to relieve the retention. This can be safely done, as immediate cauterization of the area where the specimen is secured will obviate the possibility of dissemination of cancer cells.

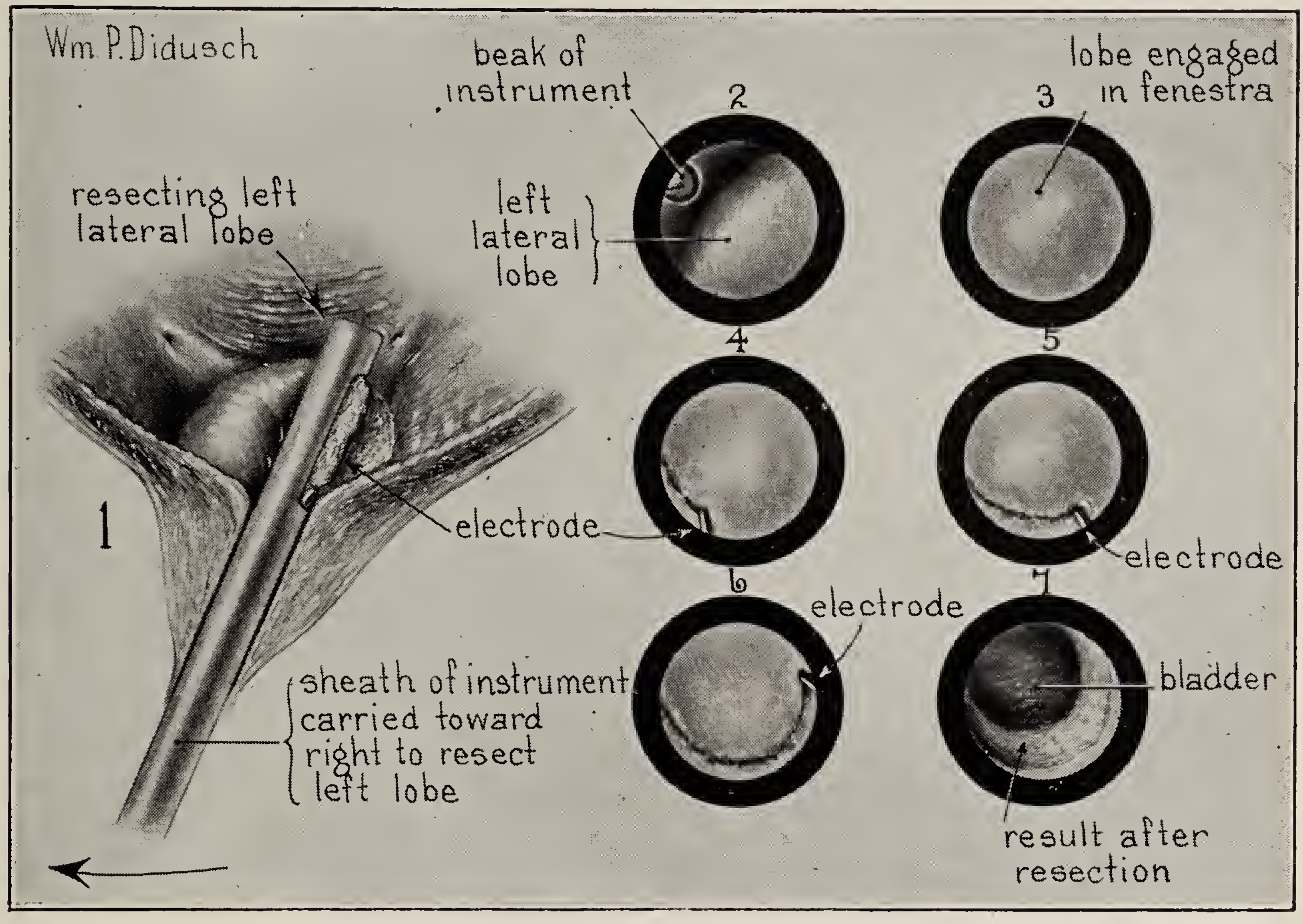

FIG. 36. Resecting left lateral lobe. (1) View of bladder and vesical orifice, showing shaft of instrument carried well to right side of patient while resecting left side of vesical orifice. The wire electrode can be seen removing a portion of the left lateral lobe. (2) Cystoscopic view of resection carried out on left side, showing left lobe of prostate and beak of instrument. (3) Lobe engaged in fenestra and now in position to resect. Note that beak of instrument cannot be seen. (4) Shows electrode beginning to cut through the prostatic tissue (beginning of arc) from left to right. (5) Further movement of electrode through tissue. (6) Electrode about to complete cut. (7) View of result after cut has been made. Shows bladder, and a large groove through prostate. (Courtesy of Amer. Journal of Surgery.)

When employing vesical neck resection in a proved case of carcinoma, the object is merely to establish drainage, improving the general systemic

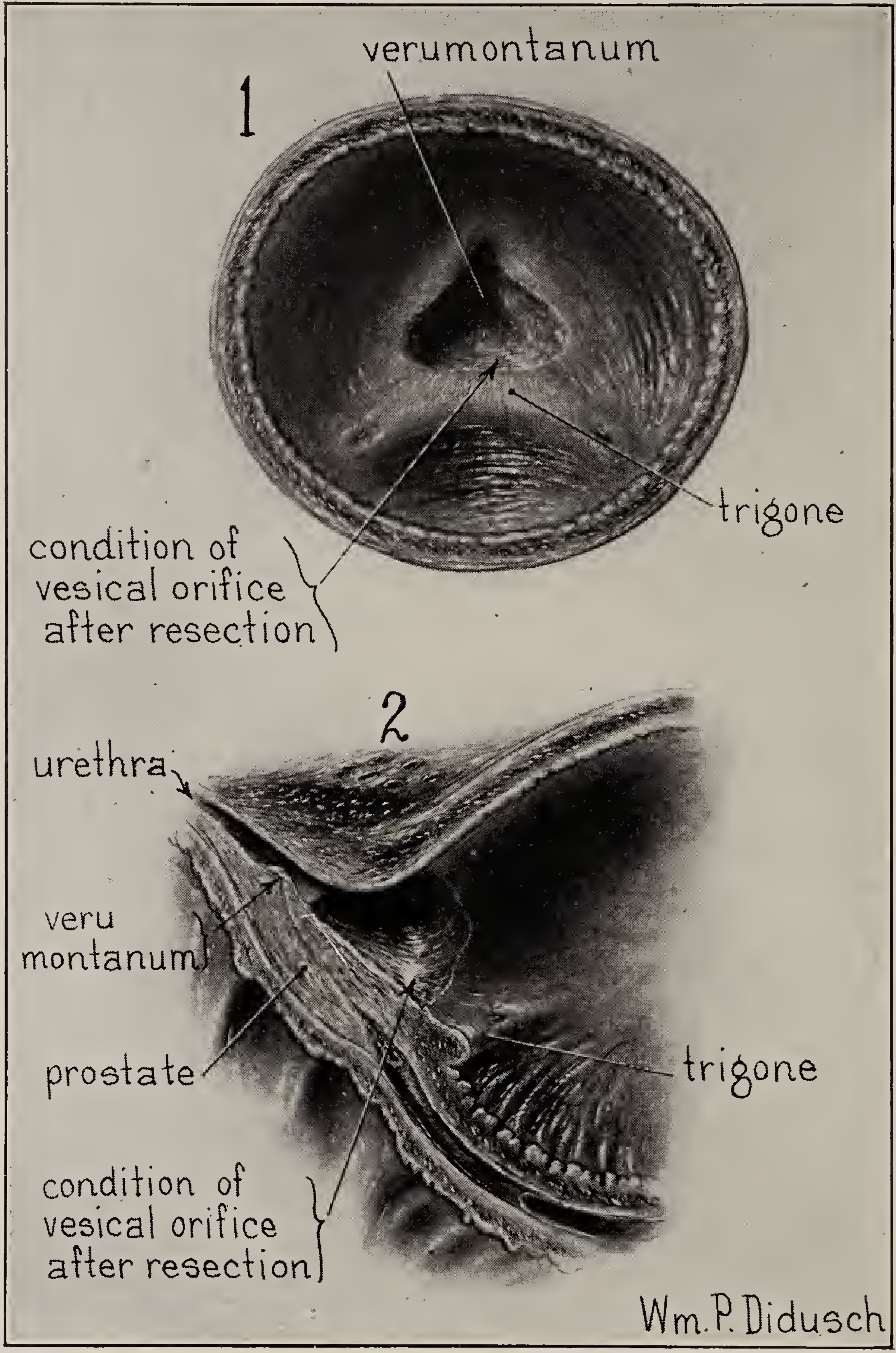

FIG. 37. Results of rotary resection. (1) Vesical orifice from within the bladder showing cone-shaped cavity from which obstructing hypertrophied tissue has been resected. The verumontanum is seen within the urethra. Although resection has been carried downward to the trigone, the interureteric ridge remains undamaged. (2) Sagittal section of same, showing smooth conical cavity at vesical orifice which extends about 1 cm. behind the verumontanum and well out upon the trigone. (Courtesy of Amer. Journal of Surgery.)

state as well as the local conditions in the urinary tract so that measures for treating the malignant disease can be put into effect with better hope of success. The majority of these patients are in no condition to undergo a major operation when they first come under examination, but following intraurethral relief of the urinary obstruction it is often possible to improve them sufficiently by judicious care to make the undertaking of some operative procedure feasible.

In the intraurethral treatment of vesical neck obstruction we have gained access to a most useful procedure for adequate handling of a pathologic condition long regarded as peculiarly difficult to control. It is estimated that 95 per cent. of men over 55 years of age suffer from some degree of interference with the normal outflow of urine from the bladder. Though this does not mean that any such proportion become subjects for operative interference, it nevertheless indicates how highly important to every practitioner of medicine is ability to deal with these conditions. In the technique which the present author has evolved there is presented an easily available, rapid, safe, and conservative method of handling the majority of cases of urinary obstruction due to pathologic conditions at the bladder neck. It is recommended as offering a solution to some of the most vexatious problems encountered in urologic practice.

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ROENTGENOLOGICAL DIAGNOSIS OF DISEASES OF THE GENITO-URINARY TRACT

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Historical note. The discovery of the x-ray by Roentgen in 1895 was first applied as an aid in the diagnosis of diseases of the urinary tract by J. McIntyre, who in 1896 detected calculi in five patients. A twelve-minute exposure with a six-inch spark coil was used and the size and location of the calculi demonstrated by the x-ray were later confirmed at operation. It was early prophesized that if the technique was improved and the danger of burns lessened the x-ray would prove a valuable adjunct in the diagnosis of diseases of the kidneys. It was soon used by numerous surgeons and in 1899 Abbé reported 27 cases in which the stones detected by the x-ray were confirmed at operation. Before this time, Tuffier had conceived the idea of outlining the course of the ureter by taking a roentgenogram of an inserted catheter containing an opaque metallic wire. Two years later Schmidt and Kolischer employed catheters containing lead for the same purpose. The use of these opaque catheters was of great importance in locating suspected shadows. It also enabled one to ascertain the position of the ureter and kidney and even to diagnose hydronephrosis by observing the coiling up of the catheter in the enlarged pelvis.

It was not long before the idea of filling the natural cavities in the body with an opaque substance, such as bismuth which is readily demonstrable by x-ray, was applied to the kidney. Numerous unsuccessful attempts to demonstrate the size and contour of the pelvis were made, until in 1906 Voelcker and von Lichtenberg succeeded by injection with collargol. This important diagnostic procedure was extensively used by its authors and soon enthusiastically received by investigators who have written widely on the subject. It was first introduced into France by Albarran and Ertzbischoff in 1908, and later extensively used by Legueu and Papin, popularized in the United States by Braasch in 1910 and introduced into England by Thomson-Walker and Kidd, who published detailed reports in 1911 and 1914. The application of the fluoroscope by Legueu, Fey and Truchot as a diagnostic aid in observing the motor activity of the pelvis has made it possible to study its filling and emptying and to observe stasis. Previous to this it had been successfully employed by Cross who did not report his observations until 1926. In 1910 Braasch employed pyelography as a routine method of diagnosis of kidney lesions using collargol (10 to 15 per cent.), and diagnosed a large number of cases of hydronephrosis, calculi of the kidneys, renal tuberculosis, tumors, ectopic and movable kidneys. Pyelography was early found not to be without danger and a number of fatalities followed its indiscriminate use. The exhaustive studies of Young and Papin, reported before the International Urological Congress in 1924, have indicated that improvement in technique and choice of non-toxic media have enabled it to be used in indicated cases without danger. Its great aid in determining lesions of the kidneys was acknowledged and the more toxic insoluble silver salts gave way to the more harmless thorium nitrate, sodium bromide and sodium iodide.

In more recent years the discovery of new signs and the employment of new procedures have made the diagnosis of diseases of the genito-urinary tract more accurate. The introduction of intravenous urography by von Lichtenberg and Swick in 1929, which came after a long period of scientific investigation, gives us a new method of roentgen diagnosis. It is not within the scope of this chapter to discuss intravenous urography, and, although this method is very popular, and is now in general use, and although it is of great aid in diagnosis, particularly in children and when obstructive phenomena are present, poor secretion of the dye sometimes leads to incomplete filling of the urinary tract and quite often results in confusion and erroneous conclusions. In shock, and in kidneys in which the function is considerably reduced or entirely destroyed, no shadow is obtained. As time has gone on improvement in the technique of performing retrograde pyelography and the general use of less irritating and less toxic opaque solutions have minimized reactions, i.e., pain and discomfort experienced by the patient. One can now say that retrograde pyelography can be employed on nearly all cases coming to the physician for investigation.

ROUTINE ROENTGENOGRAPHY OF THE GENITO-URINARY ORGANS

In taking routine roentgenograms of the urogenital tract, the size, shape and position of the kidneys can often be demonstrated. The ureters, urethra and seminal vesicles are not demonstrable unless they have been previously injected. The filled bladder and the prostate may sometimes be seen if the proper technique is employed. To ascertain the degree of renal mobility and torsion one should take films of the kidneys in the vertical as well as in the dorsal position. The development of specially devised cystoscopic tables by Young, Squier, Braasch and Lowsley, has aided technical details associated with roentgenography. These tables permit the taking of the films in the horizontal, upright and Trendelenburg positions without moving the patient from one table to another. Newer models provide for utilization of the Bucky diaphragm.

Technique. In large, obese patients, because of the thickness of the fat and musculature and because of intestinal contents, the ordinary films often fail to demonstrate the kidneys or renal calculi. Careful preparation of these patients will often eliminate the obscuring intestinal contents. This consists in the administration of 45 c.c. of castor oil on the night before and an enema in the morning. In some cases purgatives seem to aid in the formation of gas, causing the kidneys to be less distinguishable, but in many instances this can be prevented if a light dinner is given on the night before and the patient is made to fast on the morning of the film. Small stones in the line of the ribs are often hard to distinguish. Béclère pointed out that pure uric-acid calculi are not demonstrable by the x-ray and that the opacity of the calculi varied with their thickness and chemical composition. Young stated that in 180 roentgenograms of cases containing kidney stones 83 per cent. were seen. In 114 cases of urinary calculi in the urological service of Saint Mary's Hospital, San Francisco, diagnosed by Dr. Monica Donovan, two (1.7 per cent.) were overlooked. An uric-acid ureteral calculus failed to cast a shadow on the film and a calcified gland was mistaken for a stone in the pelvis. Some of the earlier cases were probably overlooked by improper preparation of the patient and faulty technique. The number of positive findings has been increased by improvement in preparation and technique. Particles of bismuth retained after an x-ray examination of the gastro-intestinal tract may give rise to confusion. Likewise, fecoliths in the appendix or elsewhere may be misleading. Phleboliths are often a source of error, but in the greater majority of patients they can be ruled out by their shape, density and position, by noting their relation to the shadow-casting catheters and to the injected ureter, and by employing stereoscopic films.

Stereoscopic films give accurate information, not only as to the thickness of the organs making up the urinary tract, but also as to their relative positions among surrounding structures. The advent of the Bucky diaphragm has given us clearer detail and enabled us to demonstrate the entire urinary apparatus with one film. The interpretation of the plain film often gives us valuable information, in so far as the shadow caused by a kidney tumor may be recognized, the abnormal kidney outline observed, and the size, contour and position of one kidney relative to the other can often be seen clearly.

PYELOGRAPHY AND URETEROGRAPHY

In 1889, Tuffier demonstrated the ureter by making a roentgenogram of the ureter containing a catheter in which there was an opaque wire, but the employment of metal mandrels was given up when Goebell conceived the idea of making the catheter itself opaque by coating it with the red sulphide of mercury and later with bismuth. In France, Eynard popularized the opaque catheter of Fournier containing lead and those of Gaillard containing litharge. Later Pasteau conceived the idea of marking the catheter in centimeters, each alternative centimeter being opaque and transparent to the x-ray.

The epoch-making discovery of Voelcker and von Lichtenberg, which accurately demonstrated the renal pelvis and ureter by injection of collargol, has given us an accurate method of diagnosis of lesions of the kidneys and ureters. They first applied it to the diagnosis of hydronephrosis and suggested its value in determining renal tumors and anomalies. In 1908, Albarran and Ertzbischoff reported nine cases in which the normal pelvis, hydronephrosis, sarcoma, " cavernous type " of renal tuberculosis, ectopic kidney and ureteral stone were diagnosed by injection of 7 per cent. collargol. They noted that following pyelography the function of the kidneys was not reduced and suggested its more general application in diagnosis of diseases of the urinary tract. From 1910 to 1915, Braasch utilized pyelography to a great extent and in numerous publications called attention to its value in the diagnosis of various lesions of the kidneys and ureters. Collargol was found to be toxic when a number of fatalities followed its use although later the fault was also discovered to be partly due to improper technique. In fact, in 1912, Blum after injecting a number of kidneys in cadavers, stated that pyelography was so dangerous and difficult that the benefit derived therefrom outweighed the information obtained and therefore advised against its use. Paschkis and Necker absolutely opposed the conclusions of Blum and suggested that improvement in technique might eliminate all danger from this valuable aid in diagnosis. The early experiments of Blum, which were performed on the cadaver and on extirpated kidneys, were misleading because absence of vitality in the renal tissues facilitated the rupture of the tubules and infiltration of the parenchyma. Strassman injected various concentrations of collargol into the ureters of living rabbits under pressure. He left the solution in the ureters for various intervals and recovered it later in the cellular tissues of the hilum and in the lymphatic spaces surrounding the tubules, but not in the tubules themselves. He concluded that in avoiding increased pressure in the process of injecting the collargol, the harmful toxic effects of pyelography could be avoided. Wossidlo pointed out that if a normal pelvis was overdistended by injection the collargol entered the interstitial tissue between the tubules. If the pelvic capacity was exceeded in kidneys presenting hydronephrosis, the solution entered the tubular system of the kidneys. He also demonstrated that in traumatized kidneys the colloidal silver more readily entered into the renal tissues. In making experiments on rabbits Mason observed that collargol penetrated the straight and convoluted tubules, glomeruli and the surrounding cellular tissue. In infected kidneys he noted the formation of abscesses at the point of accumulation of collargol and pointed out the danger in injecting kidneys presenting infection and retention. Kidd reported a number of similar experiments and concluded that the element of time was an important factor. One should not employ a pressure greater than 30 millimeters of mercury for more than one minute. Pain simply signified sudden distention of the pelvis and did not necessarily indicate infiltration of the parenchyma.

It was early demonstrated by Keyes and Mohan that renal infiltration due to secondary retention of collargol following its injection into the pelvis was also a cause of bad effects in addition to injection under too great pressure. They demonstrated that the alarming symptoms that sometimes followed pyelography could be relieved by immediate drainage of the kidneys or by nephrectomy. In animals in which the kidneys were not drained or removed, lesions due to collargol developed in other organs and in the opposite kidney.

In 1913, Kelly and Lewis introduced 5 per cent. silver iodide emulsion as a non-toxic antiseptic opaque medium. Two years later Burns suggested the use of thorium nitrate as a non-toxic, watery, colorless medium for injection of the kidneys. Although very successful in his hands, it was costly and found to be toxic in the hands of other investigators. This toxicity was probably due to the fact that it was allowed to evaporate by being kept too long or that its chemical composition was changed by frequent sterilization. A fatality following the use of thorium nitrate by Braasch at the Mayo Clinic led to the experiments of Weld on the toxicity of pyelographic media. In 1918, he introduced 20 per cent. sodium bromide as being satisfactorily non-toxic. Because of the fact that the shadows cast by the 20 per cent. solution were not as great as those cast by 10 per cent. or 15 per cent. collargol, Papin suggested a 30 per cent. concentration also containing 1 centigram of oxycyanide of mercury per litre to render the solution antiseptic. In 1918, Cameron and Grandy proposed sodium and potassium iodide as a pyelographic medium. Later the potassium salt was given up in favor of the sodium salt because of the

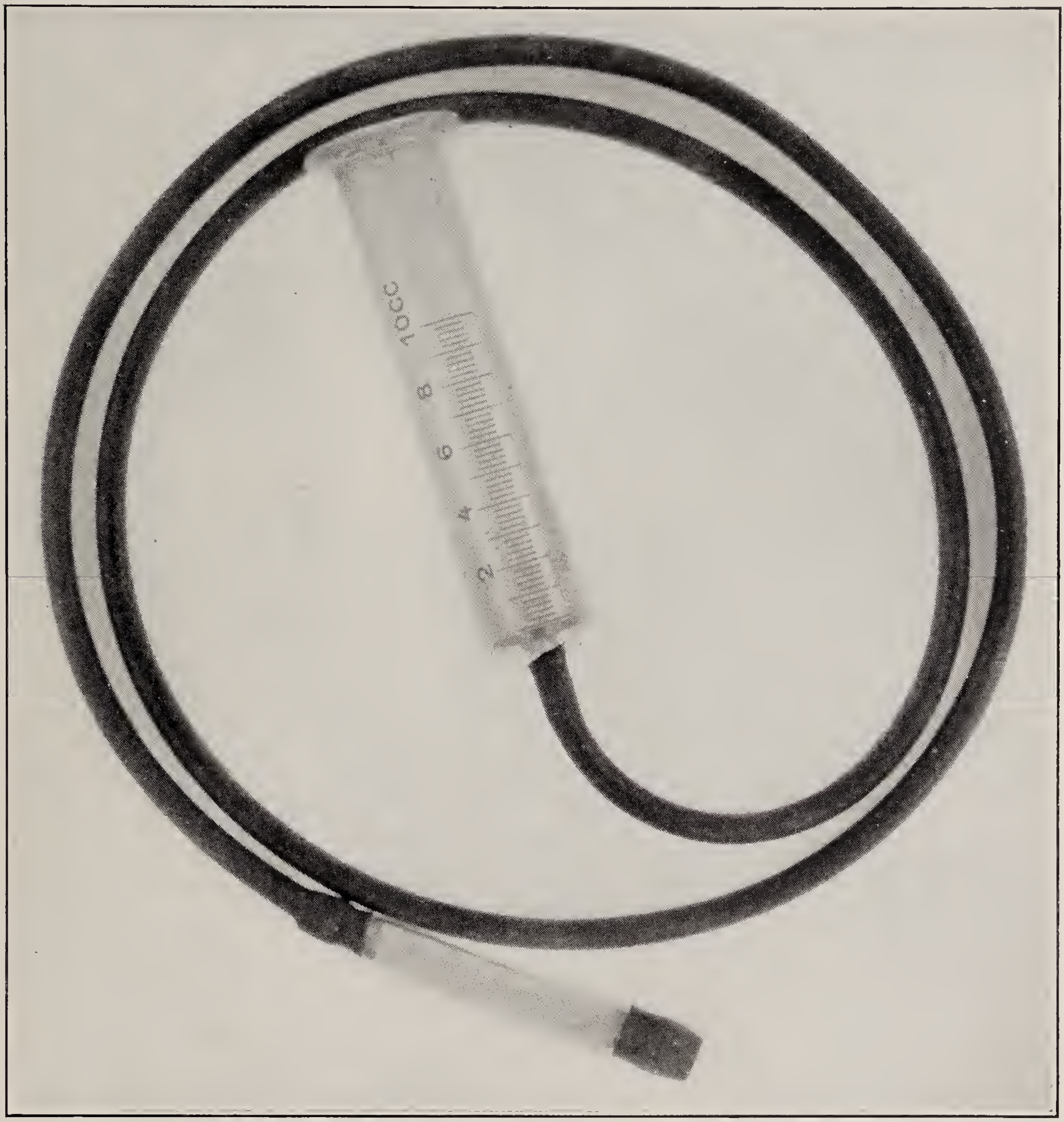

FIG. 1. Apparatus consisting of a 10 c.c. syringe attached to a small rubber tube which contains as little as 15 c.c. of the more costly non-irritating opaque solutions now used in pyelography (uroselectan, abrodil, skiodan, or neo-iopax.)

relative high toxicity of the former. In 1920, Cameron made a very careful comparative study of the relative value of thorium and of sodium bromide and iodide and of potassium iodide. He demonstrated that 15 per cent. sodium iodide was non-irritating, did not precipitate in normal or bloody urine and was as opaque as 25 per cent. sodium bromide and even more opaque than an equal percentage of thorium nitrate. Sodium iodide was nearer isotonic than any other medium employed, although it is itself considerably above blood serum in osmotic pressure. The cost of sodium bromide is less than that of sodium iodide, but this difference in price is not appreciable. After experiments with fifteen various chemicals in freshly killed beef kidneys, Lowsley and Müller came to the conclusion that 20 per cent. sodium iodide was the most satisfactory of all the opaque solutions used. It is easily prepared, non-irritating, non-toxic and casts a deeper shadow. Joseph conceived the idea of employing an opaque solution in high concentration, for instance: 20 per cent. lithium iodide, with the idea that a small amount, i.e., 15 c.c. in a pelvis with 60 c.c. capacity, would readily diffuse throughout, giving a good outline of the pelvis. By this method it was not necessary to fully dilate the kidney pelvis in order to obtain a pyelogram while slight pain, if any, was experienced by the patient. Although the theory is excellent, gravity and local pelvic spasm may prevent the solution from diffusing throughout the pelvis, causing errors in diagnosis.

More recently the solutions generally used in performing intravenous urography (uroselectan, abrodil, skiodan or neo-iopax diluted with distilled water to 40 per cent.) have been adopted as retrograde pylographic media. They are non-irritating as well as non-toxic. At the present time the choice of media seems to be between these more expensive but innocuous solutions and sodium bromide, sodium iodide, and thorium nitrate, freshly and properly prepared. All these solutions have the property of producing little if any irritation, possess remarkably low toxicity, are easily sterilized, flow freely and are very miscible with urine, and therefore do not remain in dependent sacculations of kidneys presenting stasis. They can be used practically without danger if the solution is introduced into the pelvis with little pressure. Damage can be caused by injecting any solution under too great pressure or allowing it to remain in kidneys presenting stasis.

Although an invaluable aid to diagnosis, pyelography is not without danger for it is sometimes followed by a rather severe reaction and cannot be indiscriminately employed in all cases. It is particularly contraindicated in weak debilitated patients in whom the total renal function is low. In infections of the kidneys it should not be employed during

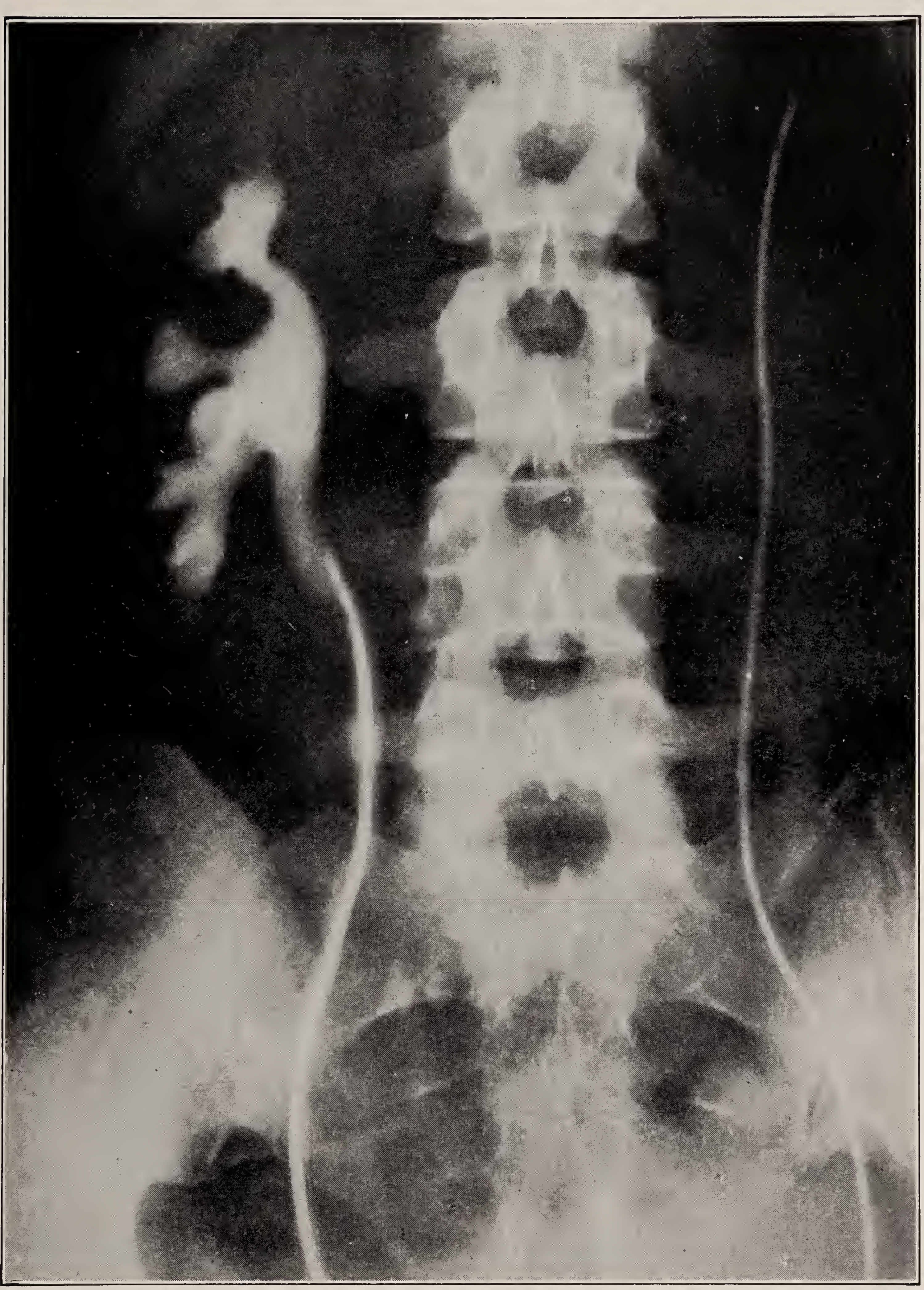

FIG. 2. Normal type of renal pelvis showing pyramidal shaped pelvis proper, the isthmi of the major calyces and the cup-shaped minor calyces. Note: Although the pelvis and kidney are normal in size and outline, the position of the organ in this picture happens to be lower than usual.

the acute stage. Although often followed by considerable pain, the accurate data obtained outweighs the inconvenience to the patient. In fact, certain obscure lesions, such as early tuberculosis of the kidneys and the localization of a small stone in the kidney, can be determined only by its use.

Technique of pyelography and ureterography, including the most recent and newest methods, modifications, improvements, and refinements in technical procedure. The technique that we recommend, and which has been developed to give the least amount of pain and discomfort to the patient and to produce the best ureteropyelograms, is as follows: The patient is placed in the hospital the night preceding the cystoscopic investigation. At 8:30 P.M. he is given sodium amytal, 0.20 Gm., and one litre of water. One and a half hours before cystoscopy he is given sodium amytal, 0.40 Gm., and another litre of water. The patient is placed in the Trendelenburg position, as advised by Bransford Lewis and Carrol, which allows the kidney to fall back into its fossa straightening out any unanchored kinks that may be present, thereby preventing the tip of the catheter from being caught in a fold, and so assuring its passage on up into the pelvis. Number 6 or 7 (Charrière) olive-tipped ureteral catheters, thoroughly lubricated with olive oil, are introduced into the pelvis. The length of the average ureter varies from 30 to 40 cm. It also varies according to the age and height of the patient, being shorter in young and smaller patients. As soon as resistence is encountered, which is usually about 30 to 40 cm. from the orifice, one should not introduce the catheter any further, as it is most probably touching the upper portion of the pelvis and forcing the catheter might perforate or injure the renal parenchyma. Chevassu, Howard, and others advise using an olivary bulb-tipped or Garceau catheter for the purpose of occluding the ureteral orifice in order to prevent back leakage when the opaque solution is injected. The advantages and disadvantages of this method will be discussed later. Ten minutes before making the pyelogram morphine 0.015 Gm. (Gr. 1/4) is injected subcutaneously. After ascertaining the capacity of the renal pelvis, uroselectan, abrodil, skiodan, or neo-iopax, diluted with distilled water to 40 per cent., is introduced by the gravity method with the patient in the Trendelenburg position. On account of the high cost of the above opaque solutions we have found it necessary to dispense with the use of the burrette and have substituted a 10 c.c. Luer syringe attached to a small rubber tube 4 mm. in diameter and 70 cm. in length, by means of which smaller amounts of these more costly opaque solutions can be used. The solution is allowed to run into the pelvis by gravity until the patient complains of a sense of fulness or pain in the region of the kidney or until the solution ceases to flow or begins to flow slowly. By the previous administration of sodium amytal many patients experience so little sensation in

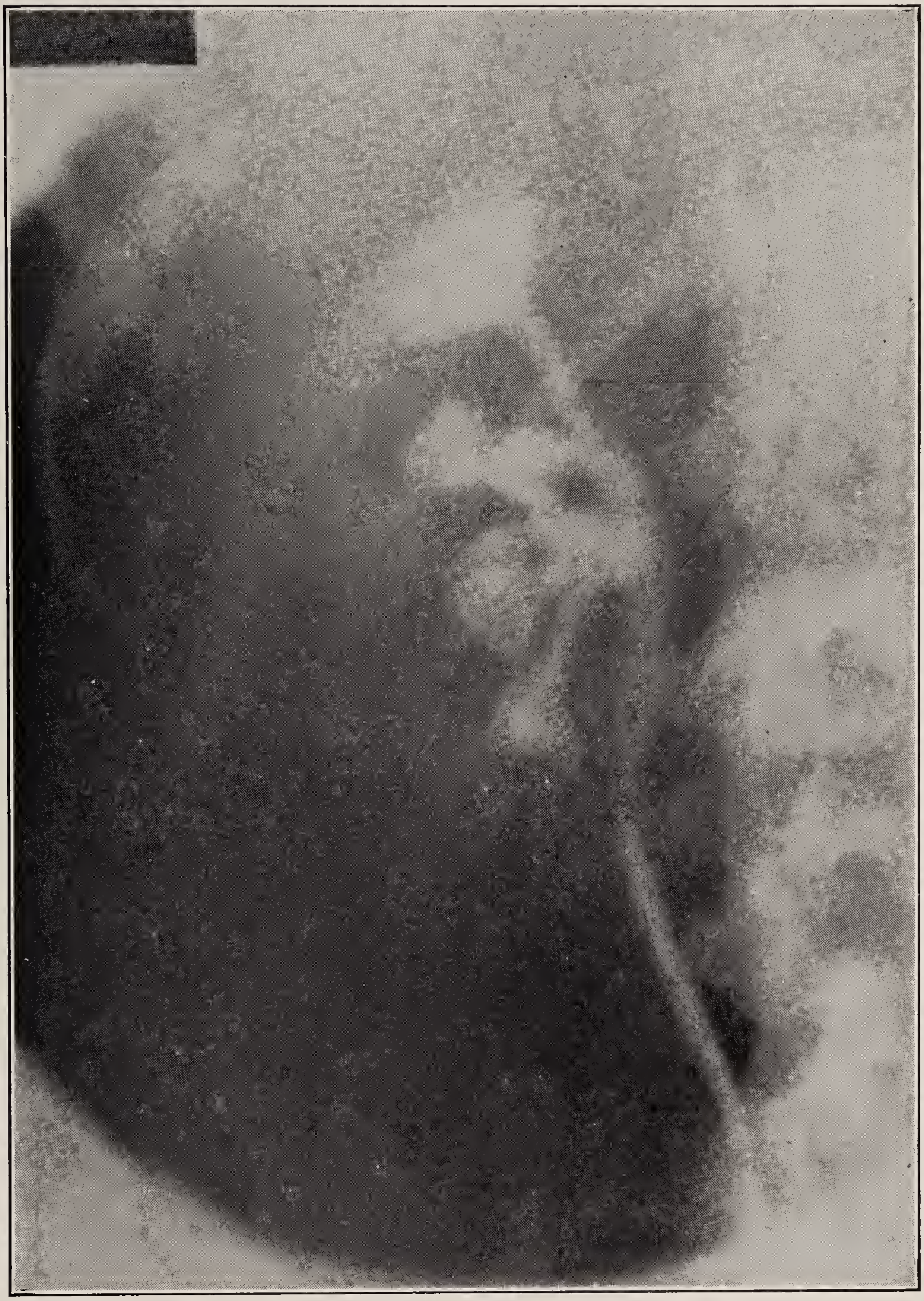

Fig. 3. Right pyelogram demonstrating unusual type of pelvis with elongation of the isthmus of the major calyces. The blunting of the calyces was probably due to chronic infection. Note also the streaky densities extending into the renal parenchyma, indicative of extravasation of the iodide into the kidney proper. (Gravity method. No ill effects.)

the kidney that one is obliged to rely on the slowing of the rate of flow, or its cessation, in order to determine when the pelvis has been filled. Films are taken in the Trendelenburg and horizontal positions. Lateral and ventral films are taken when deemed necessary. The catheter is then slowly withdrawn well down into the lower ureter, the injection being continued during its descent and while the table is being raised to the upright position. At this time it is well to raise the syringe so that the same gravity pressure will be maintained, thereby preventing the opaque solution from flowing back into the bladder. One should see that the patient is placed in the upright posture and not in a reclining position obtained by so many of the cystoscopic tables commonly in use. Before the patient has been hoisted to the standing posture it is essential that the compressing band, usually used in conjunction with taking films with the Potter-Buckey diaphragm, should be released in order to allow an unanchored kidney to make its downward excursion. The patient is asked to breathe deeply a few times and the film is taken when he has exhaled. After the completion of pyelography the opaque solution is drained away and a kidney lavage is made with a mild antiseptic solution (Rivanol 1:4000). On returning to the room, the patient is placed in a hot bath for 20 minutes, heat is applied to the kidney, ureters and bladder, and he is kept in bed for 24 hours. With this procedure, little or no pain or reaction is experienced by the majority of patients. In fact, many of them are asleep or semi-asleep when they arrive on the table and it is not uncommon for a patient to state that he has no recollection of that which went on in the cystoscopic room. A second dose of morphine (grain $\frac{1}{4}$) is given if the patient experiences any pain after returning to bed. In patients presenting renal stasis it is well to elevate the foot of the bed about 30 cm. If the patient has not had instruments passed previously it is best not to employ bilateral pyelography. A number of the reported accidents following pyelography occurred in cases in which both kidneys were injected at the same sitting. If the patient has been previously catheterized a number of times, if the more recent soluble non-toxic pyelographic solutions are employed and there is no evidence of bilateral stasis, both sides may be injected without danger.

Ureteropyelography performed by occlusion of the ureteral orifice with catheters. Certain urologists have found it difficult to fill a tube like the ureter with an opaque solution on account of leakage back into the bladder, which is likely to occur in cases in which a small catheter has been introduced into a large ureter and in those in which there is increased secretory renal pressure. In 1928 Chevassu advised the employment of an olivary-tipped catheter which is introduced into the lower ureter and occludes the ureteral orifice, preventing back leakage of the opaque solution from the pelvis and the ureter. In 1934 Howard advised using a Garceau catheter for the same purpose. There is no doubt that this procedure is of value in certain cases. However, in patients in whom there is a marked obstruction along the course of the ureter, such as advanced stricture formation, ureteral stone, malignant growth, et cetera, or obstructive lesions of the ureteropelvic junction, little, if any, of the opaque solution can be made to enter into the renal pelvis. This phenomenon will be emphasized in the discussion of the *Roentgenological Diagnosis of Movable Kidney and Hydronephrosis.* It also occurs when a large amount of thick pus or coagulated blood exists in the renal pelvis and when the secretory pressure of the kidney exceeds the hydrostatic pressure present in the opaque solution contained in the gravity apparatus. In these cases it is best to pass a catheter by the obstruction into the renal pelvis, thereby draining the pelvic sac, washing it free of pus and blood when necessary and permitting complete injection of the pelvis and ureter. There is no doubt that there are a number of cases in which this procedure of plugging the lower ureter with an olivary-tipped or Garceau catheter for the purpose of preventing leakage of the opaque solution back into the bladder is indicated; however, we do not recommend it as a routine measure and we emphasize that the employment of the technique described under *Technique of Ureteropyelography* will give the best films in the great majority of cases.

Pyelograms taken in various positions of the patient. (1) *The lateral pyelogram.* The advantages obtained by taking ureteropyelograms in the Trendelenburg, horizontal, and vertical positions have been explained. Recently Mertz and Hamer have pointed out the additional information which can be obtained by taking films in the lateral position. The lateral pyelogram can be easily made according to the technique formerly described and on any of the cystoscopic tables now in general use. It enables one to visualize the extent of rotation of the kidney, anterioposterior displacements, the course of the upper ureter as it enters the pelvis, and gives one a better idea of the outline of the renal pelvis, as well as the vertical position of the kidney. The employment of the lateral pyelogram adds to a complete understanding of existing pathology and is in some instances of great aid in making a differential diagnosis.

(2) *The ventral pyelogram.* In 1923 Laurell pointed out that in some cases interpretation of the retrograde pyelogram is difficult and has led to errors because of stratification of the injected opaque solution and the urine contained in the pelvis. He observed the phenomenon that heavy opaque solutions commonly used in pyelography descended to the bottom

of the renal pelvis and that the urine remained in a layer above. In the majority of cases this imperfect mixture of the contrast solution with the urine contained in the pelvis can be avoided by previously aspirating the pelvis, applying mild suction with a syringe. In order to avoid errors of interpretation due to stratification of these two liquids, viz.: urine and opaque solution (abrodil), Ribbing advises taking films in the ventral as well as the dorsal position. Rotating the patient produces a change in position of these stratified solutions and gives one a true conception of the contour of the renal pelvis and any changes that may be due to various pathological conditions of the kidney, thus eliminating errors of interpretation. This shifting of position permits one to visualize the excursion of a mobile kidney and also allows one to observe the different pressure defects produced by a tumor on the calyces and pelvis in the ventral as well as the dorsal posture.

Functional investigation of pelvis and ureter by means of serial films. The fluoroscopic examination of the pelvis and ureter instituted by Legueu, Fey, and Truchot (1923) enables one to observe the physiologic filling and emptying of the renal pelvis and peristaltic action of the ureter in normal individuals, as well as disturbances of function due to pathologic obstructions. Their observations stimulated further studies. However, the technical difficulties encountered in performing fluoroscopy and its nonadaptability for general use led Jarre and Cumming to attack the study of motor function of the kidney and ureter by making serial photographs rather than by employing fluoroscopy. They employ the Cinex-Camera and use film bands 5 inches wide, (10 to 12 inches wide when both kidneys are to be taken) making 10 or 12 exposures in 12 to 15 seconds, thereby recording the function of the kidney pelvis and ureter and actually demonstrating the peristaltic wave as it passes along the entire ureter. This procedure is of value as it gives one a permanent record of the physiologic action of the pelvis and ureter in health and in disease.

Combination of intravenous urography with ureteral catheterization. The discovery, popularization, and general use of intravenous pyelography has not resulted in the abandonment of cystoscopy and ureteral catheterization. The ease of its administration, the lack of reaction following, and its unquestionable convenience to the patient have made it very popular with the general practitioner. It is not within the scope of this chapter to discuss intravenous urography, and although this method is of great aid in the diagnosis of the diseases of the urinary tract, particularly when obstructive phenomena are present, poor secretion of the dye may lead to incomplete filling of the pelvis and quite often results in confusion and in erroneous conclusions. Furthermore, when kidney function has been reduced or entirely destroyed, no shadow is obtained. In order to minimize the reaction following retrograde pyelography, Wesson proposed the combination of intravenous urography with ureteral catheterization. Cystoscopy and ureteral catheterization are carried out according to the usual technique. After the kidney pelves have been drained, neo-iopax, or some similar solution, is injected intravenously and the catheters are plugged with sterile toothpicks or Victrola needles and films are taken in the usual manner and in the various positions. Wesson states that it is sometimes necessary to introduce 13–1/2 per cent. sodium iodide into the pelvis because the pelvic outline is not sharply defined (a phenomenon that frequently occurs in intravenous urography). As we have found that the employment of the opaque solutions commonly used in intravenous urography gives little if any reaction when injected into the renal pelvis, we see no advantage in employing these solutions intravenously after the ureteral catheters have been introduced into the pelves. We feel that any reaction that might occur is due either to over-injection or to the passage of the ureteral catheter itself rather than to the injection of an opaque medium that has been proven non-irritating.

In the early study of pyelography accidents were attributed to faulty technique which consisted of rupture of the pelvis due to injection under too great pressure (Rossle, Ochlecker and Von Hoffmann). Although this was true in many cases other investigators soon found that intoxication and damage to the kidney could be produced although the solutions were introduced under slight pressure. A number of investigators, notably Eisendrath, Braasch, Wossidlo, Keyes, and Mohan, undertook a series of experiments consisting of injecting various quantities of media into the pelvis under pressure. The results of these experiments demonstrated that if a certain pressure is exceeded the injected fluid will find its way into the renal parenchyma. The manner in which it enters into the substance of the kidneys varies according to the investigators. Keyes and Mohan found small particles of collargol in the lymphatics and blood vessels shortly after the time of injection in animals, or in animals in which the ureter had been ligated after the injection made under low pressure. Later, particles of collargol were seen in the tubules of the opposite uninjected kidney as well, and the investigators concluded that the collargol entered the kidney as a result of re-secretion after primary absorption through the lymphatic channels. In kidneys presenting back pressure and hydronephrosis, Wossidlo pointed out that media entered the tubules and even the glomerular spaces in greater quantity. Eisendrath showed that if the pressure used in the injection did not exceed 30 millimeters no infiltration of the kidney substance resulted. If the pressure was increased above this point, however, the tubules and glomerular spaces were filled and when it exceeded 100 millimeters of mercury, toxic symptoms rapidly developed. In these cases collargol was also found in the lungs, liver, spleen and opposite kidney. Similarly intoxication and death were produced by injecting collargol into the blood stream.

The recent work on pyelovenous back-flow by Hinman and Lee-Brown has demonstrated that the venous system of the kidney can be injected by way of the ureter as satisfactorily as by way of the renal vein, and is even unaccompanied by general parenchymal extravasation or tubular distention. They showed that the degrees of intrapelvic pressure required to produce this pyelovenous back-flow is always less than the maximum secretory pressure, often beginning at 20 millimeters of mercury. They demonstrated that ascending pyelovenous flow occurred more readily in kidneys presenting back-pressure and hydronephrosis. It is apparent that any substance injected into the kidney at too high a pressure will pass into the veins and will produce as great toxicity as if injected intravenously.

It is apparent from these experiments that the following precautions should be taken in performing pyelography: (1) One must avoid too great pressure at the time of injection, which should not exceed the secretory pressure of 60 millimeters of mercury, without possibility of gross injury to the kidneys and the introduction of toxic substances into the blood stream. (2) The retention of the injected media in kidneys presenting stasis, in which cases there is possibility of delayed absorption of toxic substances into the blood stream. This can be accomplished by employing the least toxic medium, which Lowsley and Müller have demonstrated to be sodium iodide with 20 per cent. concentration, and by not exercising too great pressure. It is best not to exeeed 30 millimeters of mercury pressure by the gravity or the syringe methods. (3) The element of time is important and the roentgenogram should be taken immediately at the completion of injection of the pelvis. (4) One should carefully drain away the injected media. Particularly in kidneys presenting stasis and infection the pelvis should be thoroughly washed out with sterile water in order to assure removal of the injected solution.

Consideration and treatment of reaction following ureteropyelography. With the improvement in the technique that has been developed in recent years and by the employment of non-toxic and less irritating opaque solutions in the renal pelvis, severe reactions following ureteropyelography have been greatly reduced. This reaction consists of chills and fever, attacks of renal colic varying in severity, anuria and, in rare instances, death. Renal colic is usually due to edema in any portion of the ureter; however, it is more commonly found at the ureteropelvic junction or in the intramural portion of the ureter. Trauma, resulting from the passage of the catheter or irritation produced by the injected solution, causes an edema which obstructs the ureter, which results in acute hydroureter and hydronephrosis. At the Southern Pacific General Hospital we have studied a number of these cases, presenting severe attacks of renal colic following ureteropyelography, most of which followed injection of sodium iodide 13–1/2 per cent. We observed that in some cases, in which the original examination showed no dilatation of the ureter and pelvis, considerable hydronephrosis and hydroureter had developed, which was well shown in a pyelogram made some 5 to 7 days following the first

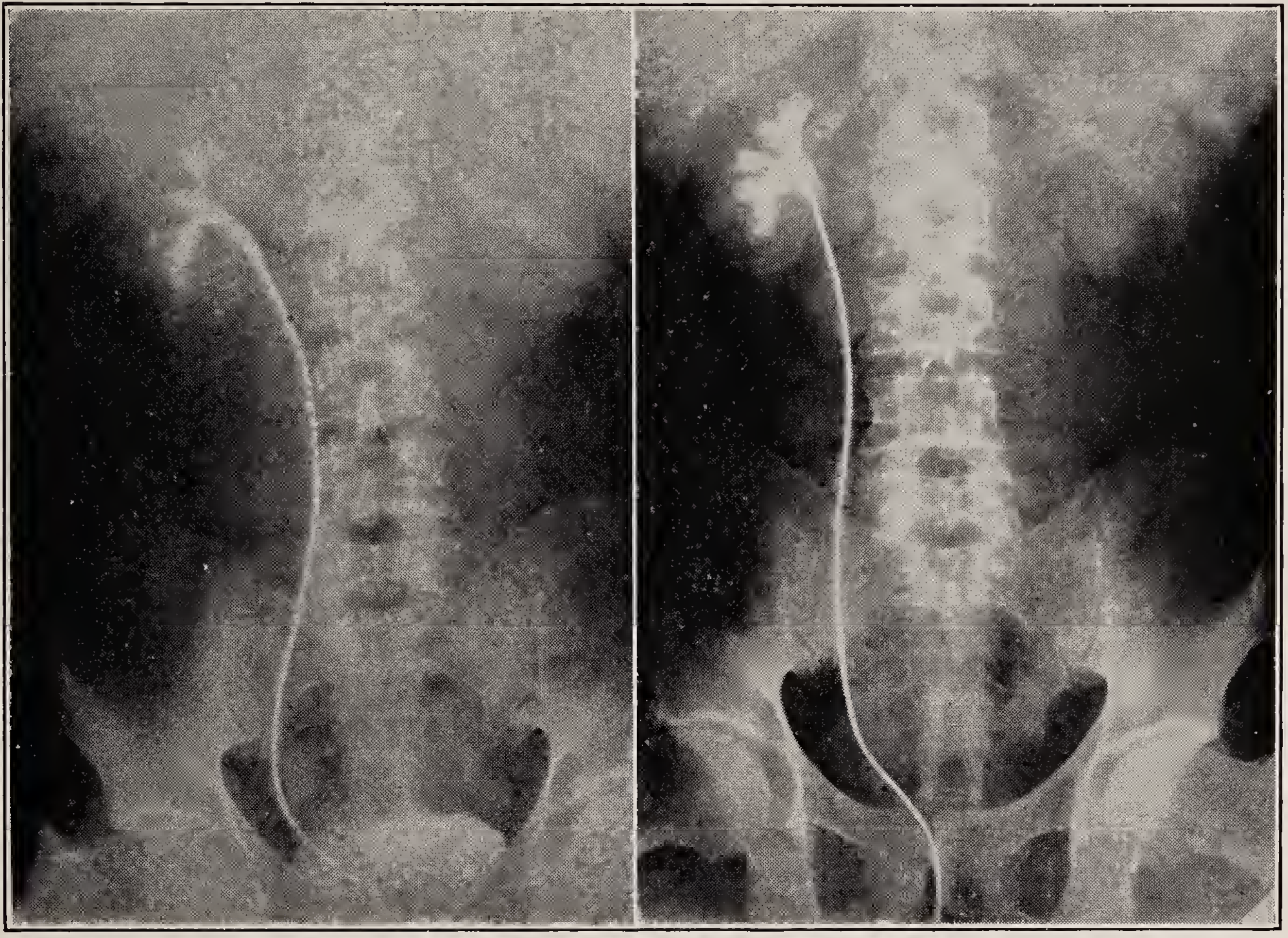

FIG. 4a. Pyelogram exemplifying acute hydronephrosis following pyelography. Original ureteropyelogram made by the injection of 13–1/2 per cent. sodium iodide, after which severe reaction followed consisting of repeated attacks of renal colic, nausea, vomiting, et cetera.

FIG. 4b. Ureteropyelogram taken five days later, showing acute dilatation of the pelvis and ureter due to edema of the lower ureter caused by irritation of opaque solutions and passage of catheter.

examination. (See Figs. 4a and 4b.) These reactions are much more likely to occur when an obstructive lesion is encountered in the ureter, viz.: ureteral stricture, kinking of the ureter due to ptosis or undue mobility of the kidney, ureteral tumor, et cetera. It is less likely to occur in cases presenting fairly advanced hydronephrosis and hydroureter, in which the kidney and the ureter seem to have become accustomed to distention. It is also less likely to occur in cases of ureteral and renal stone accompanied by obstruction, as the passage of the catheter usually dislodges the stone and permits drainage. These attacks of renal colic are often accompanied by a severe vomiting, resulting in dehydration of the patient, acidosis, et cetera. It is best treated by elevation of the foot of the bed, hypodermoclysis, and intravenous administration of glucose (small amounts of 25 per cent. or 1000 c.c. of 10 per cent.). In some cases this condition can be relieved by the passage of a small olive-tipped ureteral catheter. Anuria is a more rare complication and is due to mechanical obstruction described above, to a reflex inhibition of secretion or to congenital defects (atrophy, et cetera) or advanced pathological lesions in the kidney (nephritis, et cetera). A case exemplifying inhibitory neurorenal reflex is that of a missionary priest presenting a stone of the lower left ureter which recently came under our observation at St. Mary's Hospital. A complete cystoscopic study, including ureteral catheterization and ureteropyelography had been made a week before. Following the cystoscopic maneuver, consisting of dilatation of the ureter containing the stone for the purpose of producing its spontaneous passage, complete anuria followed. At the time of the second cystoscopy, no catheter was introduced into the right ureter and the right kidney was seen to be functioning normally, as evidenced by a normal ureteral spurt from the right orifice. Fortunately, following the treatment which we have outlined above, complete anuria of 36 hours' duration, was finally relieved. Lowsley and Harbach have recently called our attention to this type of traumatic anuria, reporting 5 cases, three of which terminated fatally. Caulk favors the theory that anuria is usually due to obstruction resulting from edema of the ureteropelvic junction. On the other hand, Eisendrath considers the principal factor in these cases to be that of reflex inhibition of secretion. The forcing of fluid, giving 1 litre the night before and on the morning of the cystoscopic examination and the performance of ureteropyelography, is of unquestionable prophylactic value. Most of the cases of anuria due to mechanical obstruction can be relieved by the measures outlined above and by the establishment of drainage produced by the passage of a small catheter. The cases of reflex anuria are usually more serious and offer a greater problem for relief. In these,

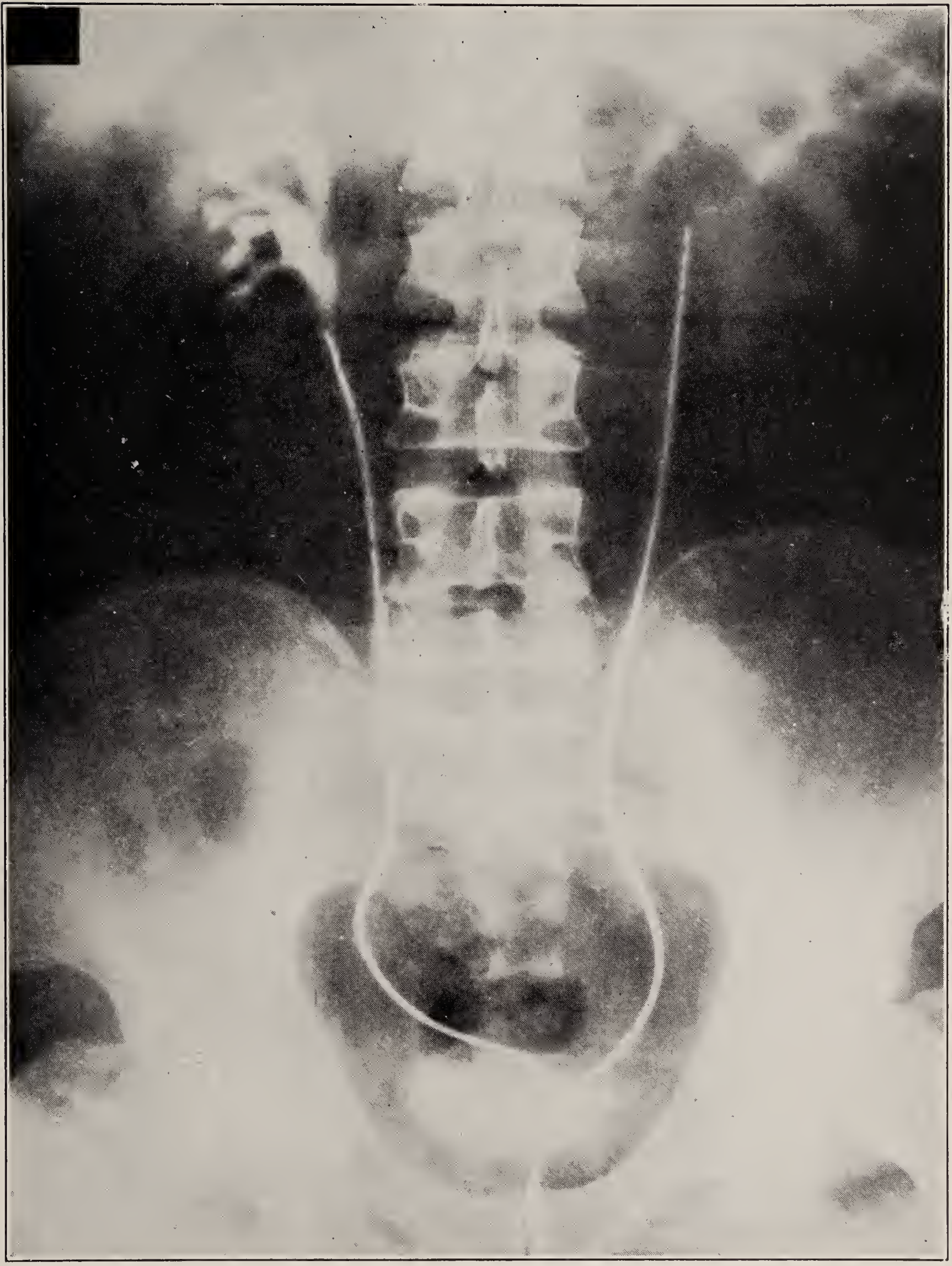

FIG. 5. Right pyelogram showing bifid type of renal pelvis. Normal calyces.

forcing of fluids, medicinal waters such as Vittel, Grande Source, hypodermoclysis, administration of glucose intravenously, hyperemia of the lumbar region obtained by mustard plasters, cupping, et cetera, the administration of thyroid extract, et cetera, are of great aid.

Severe reaction, consisting of chills, fever, toxemia, nausea and vomiting, are sometimes due to over-injection usually produced by the syringe method in which infected urine is forced into the blood stream through a ruptured calyx or by means of pyelovenous backflow. In describing the technique of ureteropyelography we have repeatedly emphasized the importance of not employing too great pressure in filling the pelvis and ureter with opaque solutions for the purpose of performing a ureteropyelogram. These reactions nearly always follow the injection of solutions by means of a syringe in which the pressure cannot be accurately determined except by the employment of a manometer. In these, the intrapelvic pressure should not exceed 20 mm. of mercury (Cecil). Most investigators do not employ the manometer and it is very hard to realize just what pressure is being exerted by the thumb while pressing the plunger of a syringe. With the employment of the gravity method that we recommend, there is little likelihood of forcing bacteria that are sometimes present in the renal pelvis or the opaque solution into the blood stream, particularly when the lower end of the ureter has not been plugged by an olive-tipped or Garceau catheter. In following the technique we have advised, except in cases of advanced ureteral strictures, the solution has an opportunity of passing back into the bladder if a moderate amount of over-injection should be made and this back leakage acts as a safety valve in many cases.

FLUOROSCOPY OF THE PELVIS AND URETER

In 1923, Legueu, Fey and Truchot applied fluoroscopy to the examination of the pelvis and ureter. In place of simply taking one or consecutive plates of the injected pelvis, they observed its filling and emptying and noted its motor activity and retention of injected material. In this manner one can observe the peristaltic action of the ureter, and observe disturbances of function due to pathologic obstructions in the ureter. The size and emptying time of the pelvis can be accurately seen. In this way complete and incomplete retention in the pelvis may be observed and one can tell whether it is temporary or permanent. W. W. Cross has recently pointed out that greater accuracy is maintained by injecting the kidney under actual observation. He demonstrated that there is less likelihood of overdistending the ureter and pelvis in utilizing this method. He has also followed visually the excursion taken by a movable kidney.

PNEUMO-PERITONEUM

Pneumo-peritoneum consists of inflating the abdomen with air for the purpose of outlining the kidneys in doubtful cases and of locating the exact origin of definitely palpable masses in the abdomen. The rather dangerous combination of ureteropyelography and pneumoperitoneum has been used, but is not to be recommended.

A similar procedure can be applied by creating artificial emphysema in the perinephric, fatty and cellular tissues. A fine platinum needle is introduced to a point corresponding to the second lumbar vertebra, slightly deviating the needle so as to avoid the process itself, and as soon as the needle shows oscillations one knows that it is in the perinephric cellular tissue. From 200 to 600 c.c. of oxygen gas is then injected and a film taken. In this way indistinct kidneys may be outlined and the shape and position ascertained.

This method of diagnosis is not entirely without pain and should only be utilized when the information obtained from plain films, pyelography, ureteral catherization, et cetera, is inadequate. The introduced gas is slowly absorbed in from two to seven days and if ordinary aseptic technique is employed there is no danger in its use.

DIAGNOSIS BY URETEROPYELOGRAPHY

Normal pelvis. The size, shape and volume of the pelvis vary in different individuals. In order not to mistake variations of the normal pelvis for pathologic conditions one should be thoroughly familiar with the various abnormalities most often encountered. The pelvis is made up of (1) the true pelvis, (2) the major calyces and (3) the minor calyces. In approaching the kidney, the ureter divides into two or three major calyces forming the true pelvis which is more or less pyramidal in shape, the apex being situated at the ureteral junction. The pelvis itself is made up of a medial border directed toward the vertebrae and a laterad border directed caudad and laterad. It is formed by the obliteration of the uretero-pelvic angle or bifurcation of the ureter and the widening out of the mesial border of the upper calyx.

The major calyces vary in number, three occurring more frequently than two. One should not confuse the division of one of the major calyces in the various planes of the kidney for an additional calyx. The upper and lower major calyces are fairly constant. The middle major calyx is exceedingly variable and may empty directly into the pelvis proper, into the upper calyx, or may exist as a minor calyx. It is often smaller than the other two calyces. Four major calyces rarely occur and when present are usually due to some abnormal condition of the kidney. The upper calyx is directed cephalad and sometimes slightly laterad, the middle calyx is directed laterad and slightly cephalad, and the lower calyx caudad and slightly laterad. The manner of bifurcation varies considerably, the calyces usually leaving the pelvis at an acute angle, but in occasional cases they have been observed to leave at a right or obtuse angle. The base of the calyx marks its separation from the true pelvis. It continues with the isthmus or neck which is the more or less narrowed cylindrical portion leading away from the pelvis and connecting it with the apex. The apex is the terminal portion of the major calyx and is wider than the base or isthmus and contains a variable amount of fluid. The major calyces vary greatly in their contour and direction. Their size may be so increased as to take on the appearance of a secondary pelvis. Apparent anastomosis of the different calyces has sometimes been described, but true anastomosis between the various calyces themselves does not occur. Stereoscopic plates and anatomic studies of the kidney have shown that the various calyces are situated in different planes in the kidney, making anastomosis of the calyces impossible. The isthmus between the pelvis and calyx is not infrequently found to be elongated and is a result of a tendency to reduplication of the pelvis.

In some kidneys, the pelvis proper predominates over the calyces, whereas in others the calyces make up its greater portion. One sometimes sees a particularly elongated major calyx or a general pseudo-spider-shaped pelvis which may be confused with the pressure defect caused by the compression of a renal tumor. Likewise, one or more calyces may present a short, wide isthmus.

The minor calyces vary in number and arise from the apex of the major calyces. They extend anteriorly and posteriorly in two planes. They are irregularly pyramidal in shape, rather narrow and flat, the apex of which is cup-shaped due to the evagination of the papilla. They may become rounded or irregular due to back pressure into the pelvis or to inflammatory changes that have taken place therein. They vary in size and are sometimes increased to such an extent that they appear as a large secondary major calyx.

Congenital anomalies. The various congenital anomalies encountered which may result in pathologic conditions of the kidneys and ureters

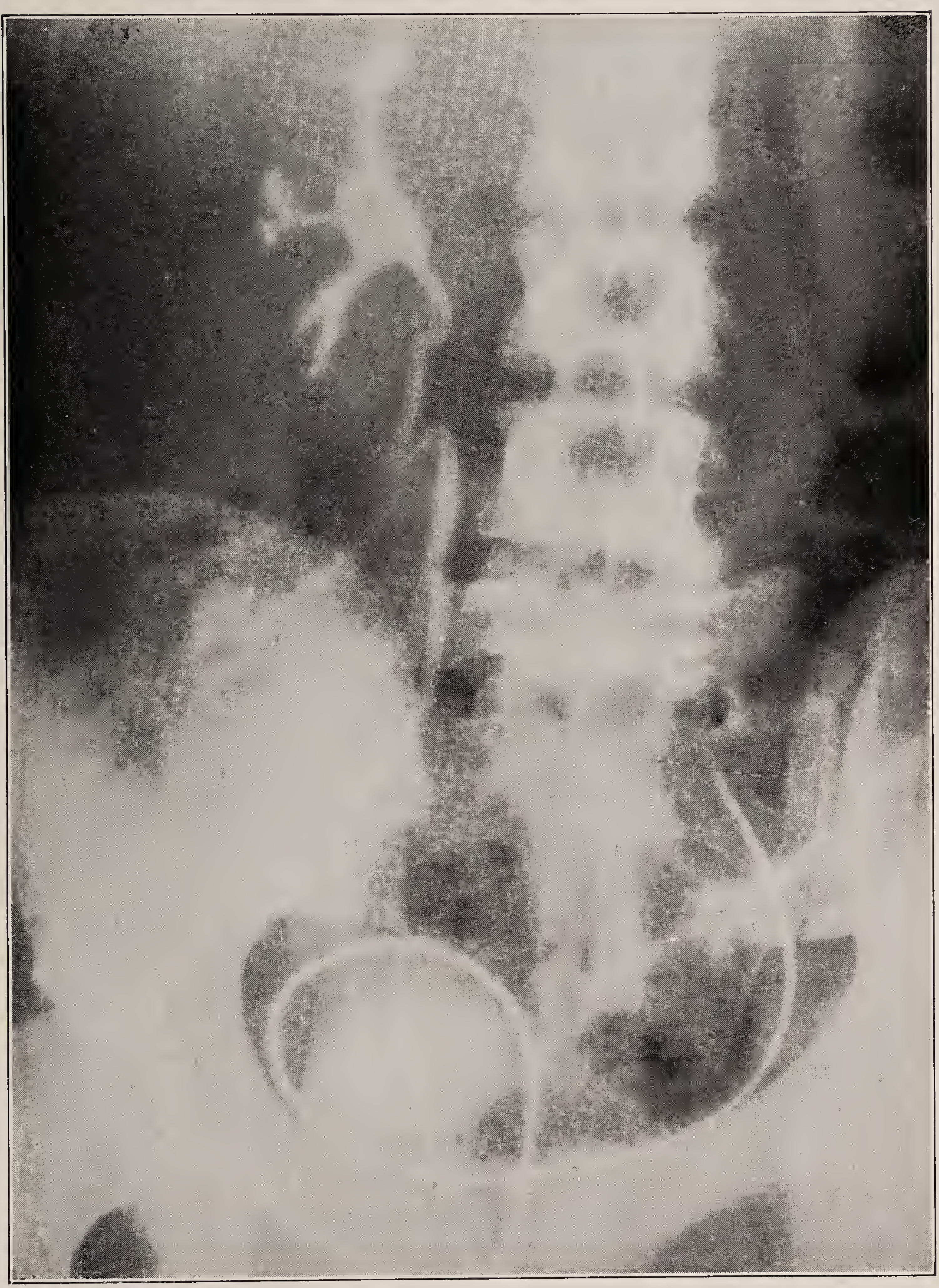

Fig. 6. Pyelo-ureterogram of trifid type of pelvis showing normal inferior and middle major and minor calyces, widening of the upper minor calyx and kinking of the ureter 2 and 5 cm. below the uretero-pelvic junction. (Note the position of the catheter which has been withdrawn well down into the bony pelvis in order to obtain complete injection of the ureter after filling the pelvis with the opaque medium.) Vol. 3. 1035.

can often be diagnosed by the employment of ureteropyelography. Formerly these were only revealed at the autopsy or operating table. Their detection by the use of the x-ray offers us an opportunity of recognizing them early, giving one a chance of attempting surgical relief. The more common anomalies may be classified as follows:

1. Anomalies as to number (a) solitary kidney (b) supernumerary kidney.
2. Anomalies as to size (a) atrophy (b) hypertrophy.
3. Anomalies as to shape (a) elongated (b) small narrow (c) lobulated kidney.
4. Anomalies as to situation (a) unilateral (b) bilateral ectopic kidney with or without fusion.
5. Fusion of the kidneys (a) horseshoe (b) sigmoid-shaped kidney.
6. Congenital renal torsion.
7. Duplication of the renal pelvis.
8. Anomalies of the pelvis (a) form (b) size (congenital hydronephrosis and decrease in the size of the pelvis).
9. Anomalies as to the number of ureters (duplication of the ureters).
10. Cystic dilatation (a) partial or total (b) of the lower portion of the ureter alone.
11. Congenital stricture and valvular formation of the ureter.
12. Diverticulum of the ureter.

Solitary kidney occurs rarely and its diagnosis should only be made after a careful cystoscopic and roentgenological search has failed to reveal its fellow. Supernumerary kidneys are often revealed by the employment of bilateral pyelography. The congenital small kidney is easily detected by injecting the pelvis, being recognized by distorsion and reduction in the size of the pelvis. In addition, there is usually a decrease in the output of urine from the " atrophic " kidney whereas the opposite kidney shows an increase in secretion due to compensatory hypersecretion. The hypertrophied kidney is considerably increased in size with a more or less relative enlargement of the pelvis, primary and secondary calyces. Fetal lobulation of the kidney may be retained and is particularly marked in those cases presenting anomalies of the blood vessels. The kidney may present variations in shape, being either elongated or narrowed.

Anomalies as to situation are not infrequent. One must be careful not to confuse the ectopic kidney with the movable type which has acquired its lowered position and has been firmly anchored by adhesions to the surrounding structures. The true ectopic kidney is one in which the entire organ is in an abnormally low position at birth and it differs from the low movable kidney in deriving its blood supply from a lower level, be it from the lower aorta, iliac, inferior mesenteric, spermatic or ovarian vessel. Its presence can be suspected by the relatively short distance that the ureteral catheter requires to pass in order to reach the pelvis, but its actual position, however, is only determined by making a pyelogram. The movable kidney in dropping usually carries the upper mobile portion of the ureter with it, and in descending causes it to kink on itself at its highest fixed point to the peritoneum. On the other hand, in the ectopic kidney the ureter is normally short and there is less likelihood of formation of a kink. One must be careful not to confuse an ectopic with a low-lying fused kidney. In the ectopic kidney the relation of the ureter to the pelvis is also unusual. It usually extends cephalad and posterior before taking its caudal course. Ectopic kidney occurs more frequently on the left side in contra-distinction to movable kidney which occurs oftener on the right side. They are occasionally bilateral.

Fusion of the kidney, commonly known as horseshoe kidney, is a term applied to union of both kidneys in the midline and can be diagnosed by the employment of bilateral pyelography. The kidney is usually quite low, the pelves being situated rather near the median line, one or both of which may present hydronephrosis. The major calyces instead of being directed laterad may be directed toward the median line. One should be careful not to confuse the radiographic picture presented by two unusually low placed kidneys which in their descent have approached each other in the median line. The horseshoe kidney may be connected by a median isthmus situated at the superior or inferior pole. In rare instances the concave borders of the two organs are fused, giving the kidney the appearance of a large single median organ containing two pelves. The lower pole of one kidney may be connected to the upper pole of its opposite fellow giving the entire organ the shape of a sigmoid.

Congenital renal torsion is caused by various degrees of rotation of the kidney on its transverse or longitudinal axis. The rotation may be incomplete or complete. In the former the rotation causes the kidney to appear flattened presenting an anterior and a posterior surface. The blood vessels and the ureter cross the anterior surface to reach the hilus. In complete torsion the hilum is situated on the posterior surface and the renal vessels and ureter cross this in order to reach the hilus. In some instances the kidney rotates on the longitudinal axis so that the convex surface is directed toward the median line and the pelvis and vessels are directed laterad, the ureter descending from the external border of the kidney.

The evolution of the duplication of the renal pelvis has been made demonstrable by the employment of ureteropyelography. It varies from degrees of bifurcation of the upper and lower major calyx to complete bifurcation in which there are two separate ureters which may join at some lower point, or may empty into the bladder itself by separate orifices. In operating on certain pathological conditions, this duplication of the renal pelvis with total separation of the upper ureter gives one the opportunity of removing either the upper or lower half of the kidney; in other words to perform partial nephrectomy. Duplication of the renal pelvis may be unilateral or bilateral and the double ureter itself may

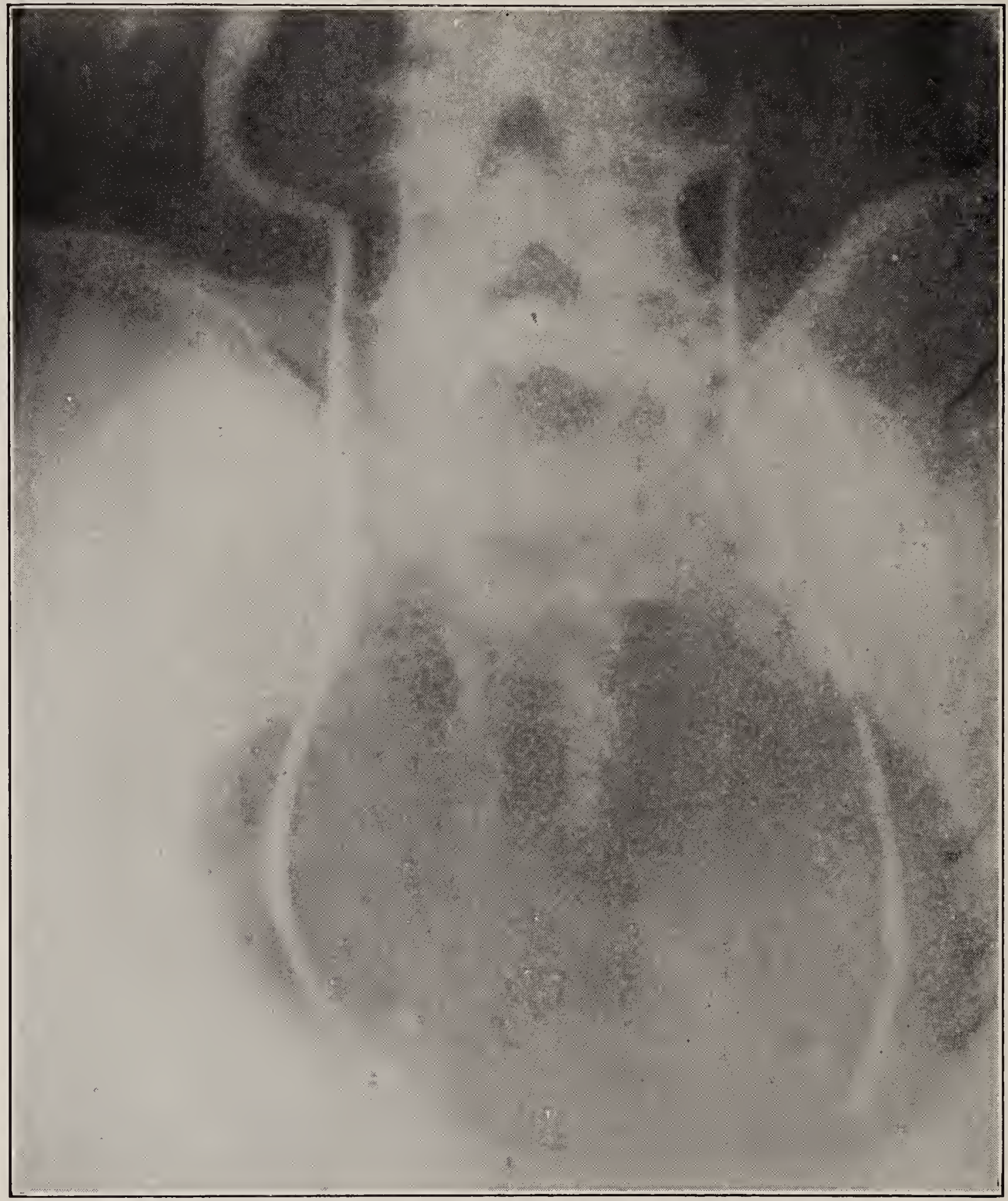

FIG. 7. Right ureterogram injected from above; nothing abnormal observed.

join its fellow at any point during its course or may open into the bladder or posterior urethra by separate orifices.

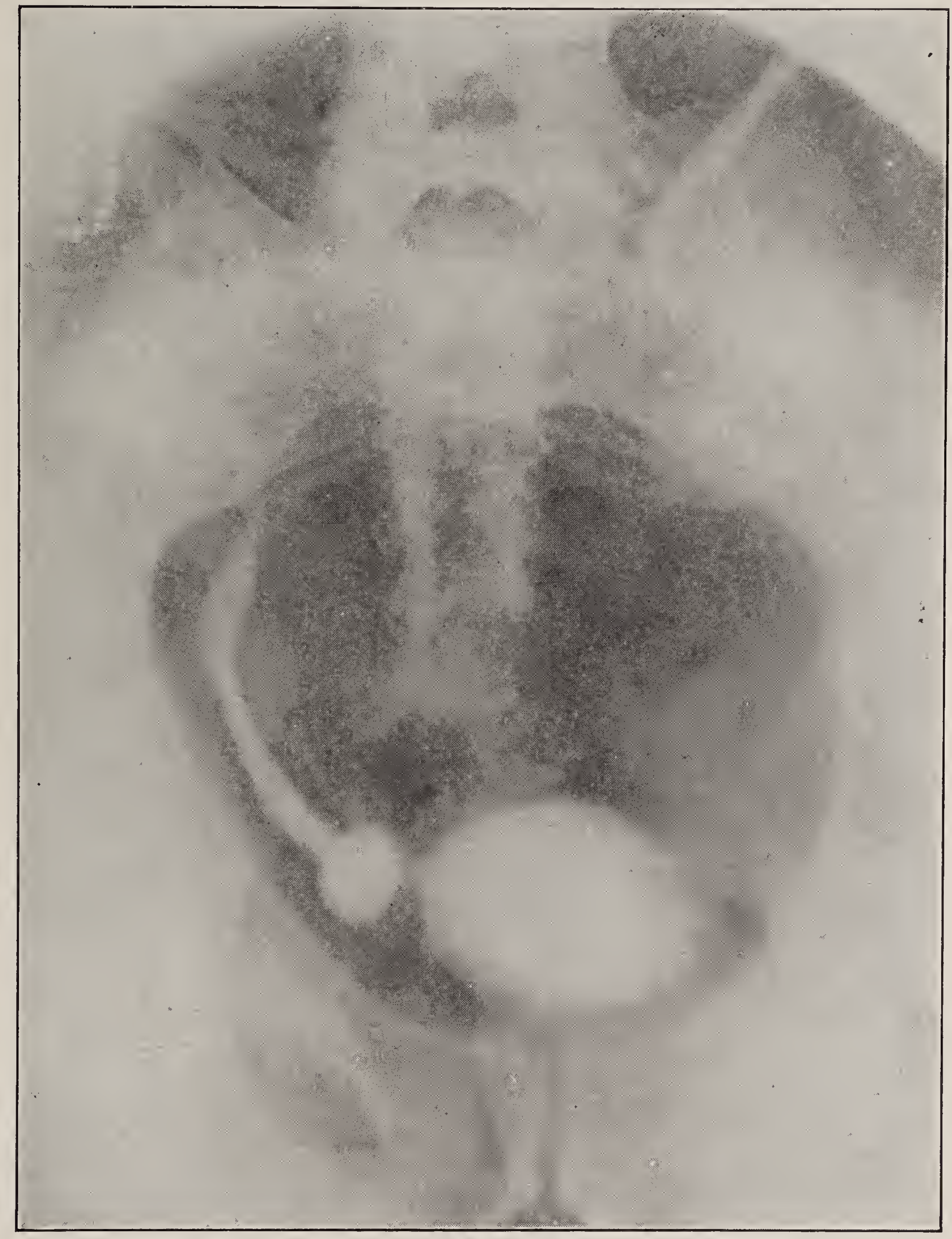

FIG. 8. Same case after withdrawing catheter and injecting, showing ureteral diverticulum proximal to bladder.

Anomalies of the pelvis vary as to its size and shape. There may be actual absence of the pelvis, the ureter dividing immediately into the major calyces. On the other hand the pelvis may be congenitally deformed, presenting the shape of a smaller or larger hydronephrotic sac with or without stricture of the uretero-pelvic junction or kinking of the

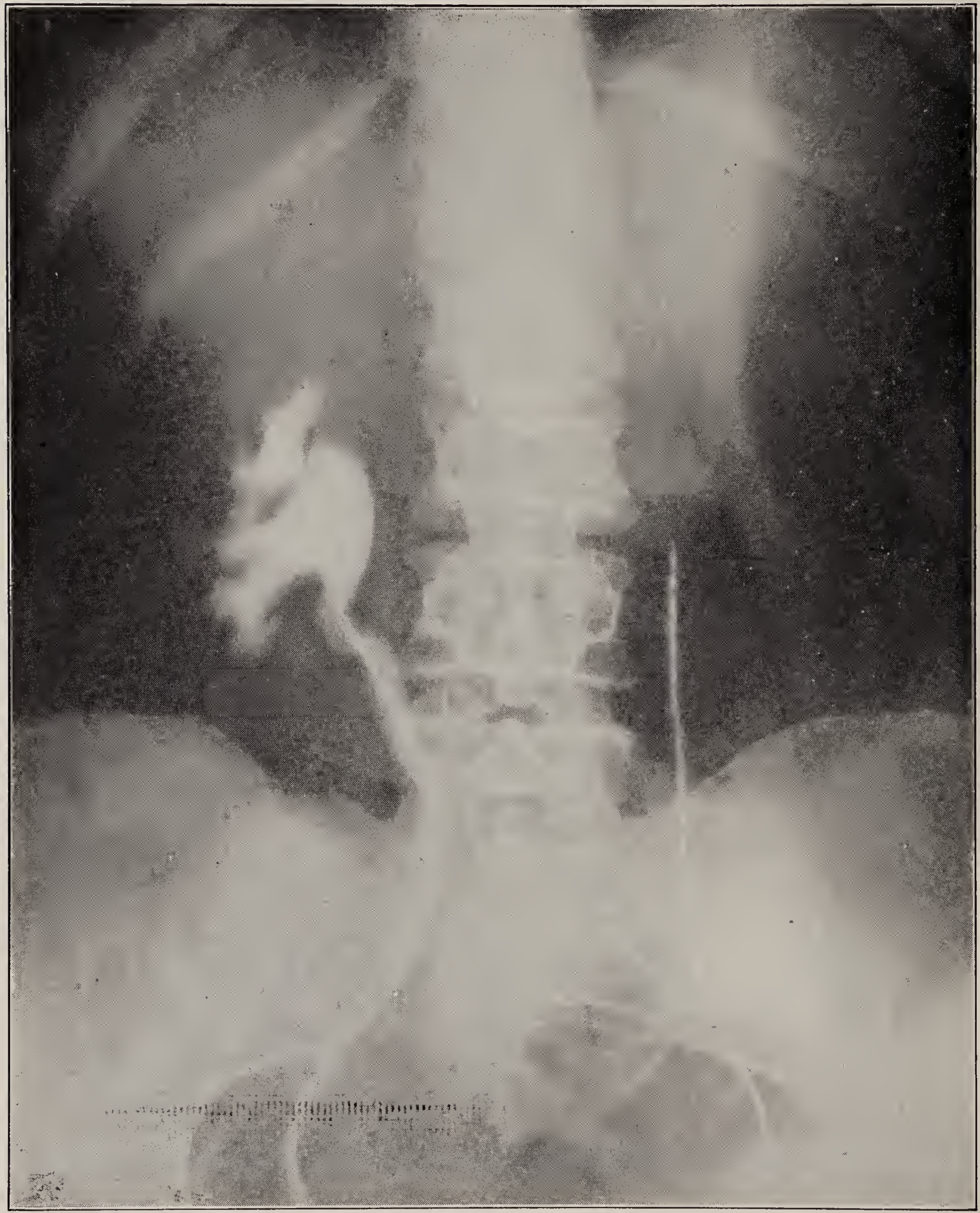

Fig. 9. Right pyelogram showing early hydronephrosis with slight dilatation and tortuosity of the ureter.

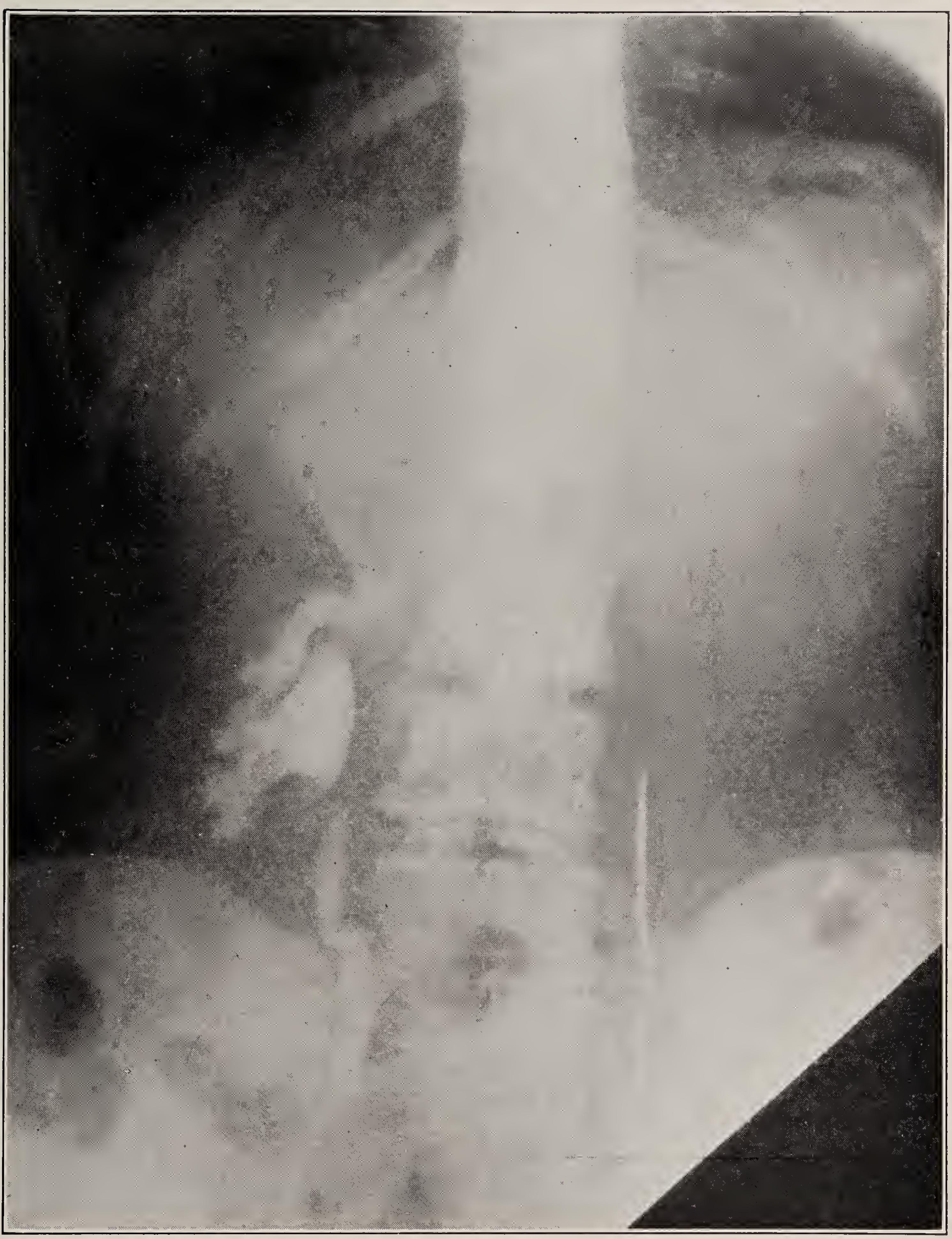

Fig. 10. Same case in vertical position showing definite ptosis and ureteral kinks. (Nephropexy with relief of symptoms.)

ureter over an aberrant vessel. In other instances it consists of a lower portion which has more or less the characteristics of a normal pelvis with a branch going to the upper pole consisting of a major calyx. (Hyrtl.) The pelvis may present a diverticulum or be saccular.

Duplication of the ureters is ordinarily co-existant with duplication of the pelves and they may join each other before their arrival into the bladder or may open therein by separate orifices. In order to detect them it may be necessary to pass a catheter into each ureteral orifice and inject them separately. In cases in which they join each other before arriving into the bladder it is necessary to withdraw the catheter well down below the point of bifurcation in order to inject both branches.

Cystic dilatation of the ureter. In order to tell abnormal dilatations of the ureter one should be familiar with the normal areas of dilatation and narrowing of the ureter. From above downward, one encounters a constriction at the uretero-pelvic junction below which the ureter is dilated; narrowing of the ureter where it crosses the pelvic brim again followed by an area of dilatation; constriction of the ureter at the point that it enters the bladder wall; ampulla-like dilatation in the bladder wall, and finally constriction at the ureteral orifice itself. These normal constrictions and dilatations may be exaggerated and in some instances the former may lead to actual stricture with back-pressure. Cystic dilatation of the ureter may be partial, only existing in the lower portion just above a narrowed ureteral orifice. This is readily seen in making a cystoscopic examination. On the other hand the dilatation may embrace the entire ureter. The ureter may be more or less tortuous presenting " valves " at various levels. The ureteral orifices usually open at each lateral apex of the trigone, but in some instances they are found to open anywhere in the trigone, posterior urethra, utricle, ejaculatory ducts or seminal vesicles.

Diverticulum of the ureter. This condition has been occasionally observed and when it exists in the lower ureter one must be careful not to confuse it with diverticulum of the bladder. In injecting the ureter one should be careful to withdraw the catheter well below its connection with the ureter in order to fill it with the opaque media.

Ureteral stricture. Although ureteral stricture may be detected by feeling the " hang " in withdrawing a bulb-catheter, its actual presence can be determined best by a good uretero-pyelogram. One must be careful not to confuse the normal narrowings caused by the peristaltic action of the ureter or by any of the four anatomic narrowings of the lumen of the ureter. In the case of a true congenital or acquired ureteral stricture one will observe dilatation of the ureter and pelvis above the point of constriction.

MOVABLE KIDNEY AND KINKING OF THE URETER

In the majority of cases the diagnosis of movable kidney can be made by careful palpation of this organ in the horizontal and vertical positions. Good plain films are of great value in determining the size, shape, position and excursion of the kidneys and in excluding stones, renal tumors or enlargements of the other abdominal organs. Pyelography, however, permits one actually to determine the mobility of the kidney, to differentiate it from other abdominal organs or tumors and to ascertain any stasis that might have resulted from its lowered position. A careful uretero-pyelogram shows the relative immobility of the lower ureter and any kinking or plication that might result from the descent of the kidney. It often clearly demonstrates the more immobile lower portion of the ureter which, being fixed to the peritoneum, does not sag with the more mobile upper third, resulting in its kinking at its highest point of fixation. The careful use and interpretation of the findings elicited by the bulb-catheter will allow one to differentiate this from ureteral stricture. One should not fail to realize that renal ptosis with kinking of the ureter may co-exist with ureteral stricture, each requiring individual treatment.

The technique of ureteropyelography, in cases suspected of having movable kidney, should be made in the following manner: The catheter is passed into the renal pelvis and a pyelogram is made. In taking the film the catheter will often act as a splint and straighten out a pre-existing kink of the upper ureter, giving one an erroneous conception of the true pathological condition. On the other hand in inserting the catheter the tip may be caught in the ascending limb of the proximal loop of a ureteral kink, preventing it from passing into the pelvis. In this event one should place the patient in the exaggerated Trendelenburg position which causes the kidney to drop back into its fossa, thereby straightening the ureteral kink and allowing for subsequent passage of the catheter or the injection of the opaque medium. After the first film is taken, one should withdraw the catheter well down into the bony pelvis and inject from below, making a complete uretero-pyelogram, in the horizontal and vertical positions. In some cases the kink will only be demonstrated in the vertical position but when adhesions have formed between the ureter and an aberrant vessel or fibrous band it may have become permanent and demonstrable in both positions.

The kidney is usually considered to occupy a position opposite the 11th and 12th thoracic and the 1st and 2nd lumbar vertebrae, the right being lower than the left. It moves with respiration, having a normal range of motion of 2 to 5 cm. It may have no mobility, being more or less anchored in place by adhesions due to old perinephritis. In movable kidney in which the increased mobility ranges from 5 to 15 cm., the organ

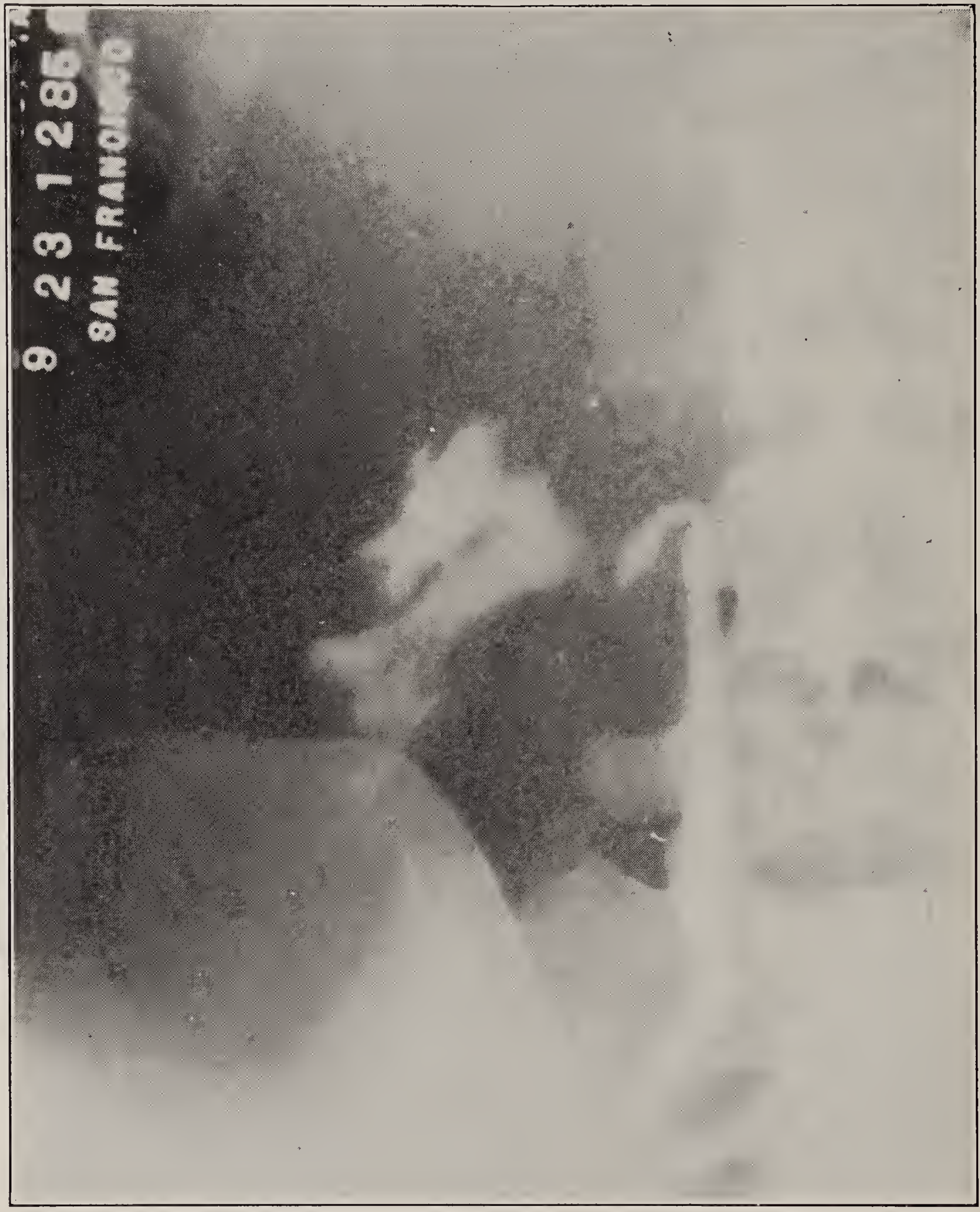

FIG. 11. Early hydronephrosis possibly secondary to renal ptosis and kinking of the upper ureter. Perinephritic adhesions have anchored the kidney which remains low even in the horizontal position.

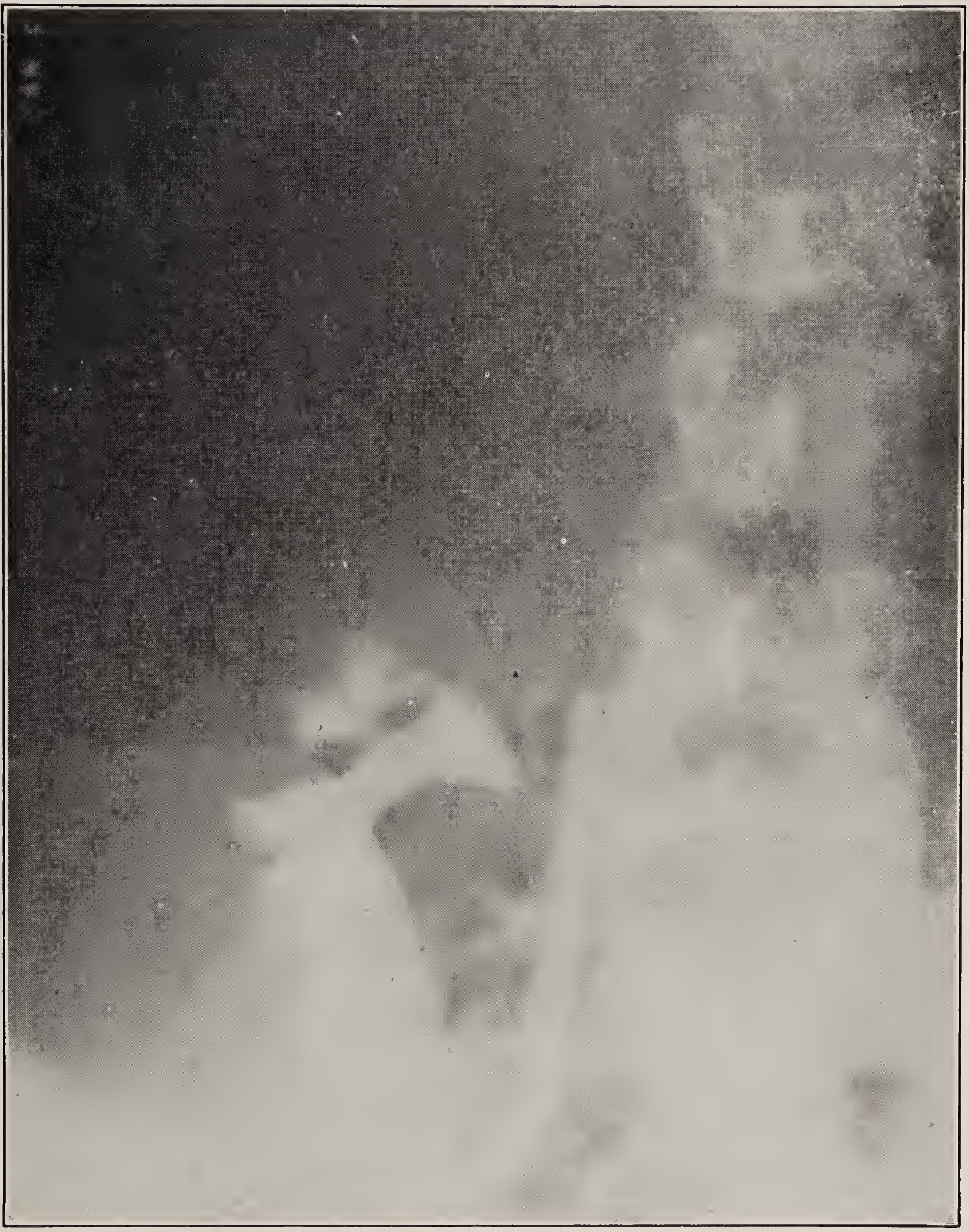

Fig. 12. Same case in vertical position. (Nephropexy with relief of symptoms. No stricture found to explain the slight hydroureter.)

usually drops mesially and caudally because of the peculiar formation of the peri-renal fascia. The kidney may rotate on its transverse or longitudinal axis, resulting in acquired renal torsion. In descending it sometimes does not carry the entire ureter with it causing more or less acute kinking at the highest point of ureteral fixation, which frequently cor-

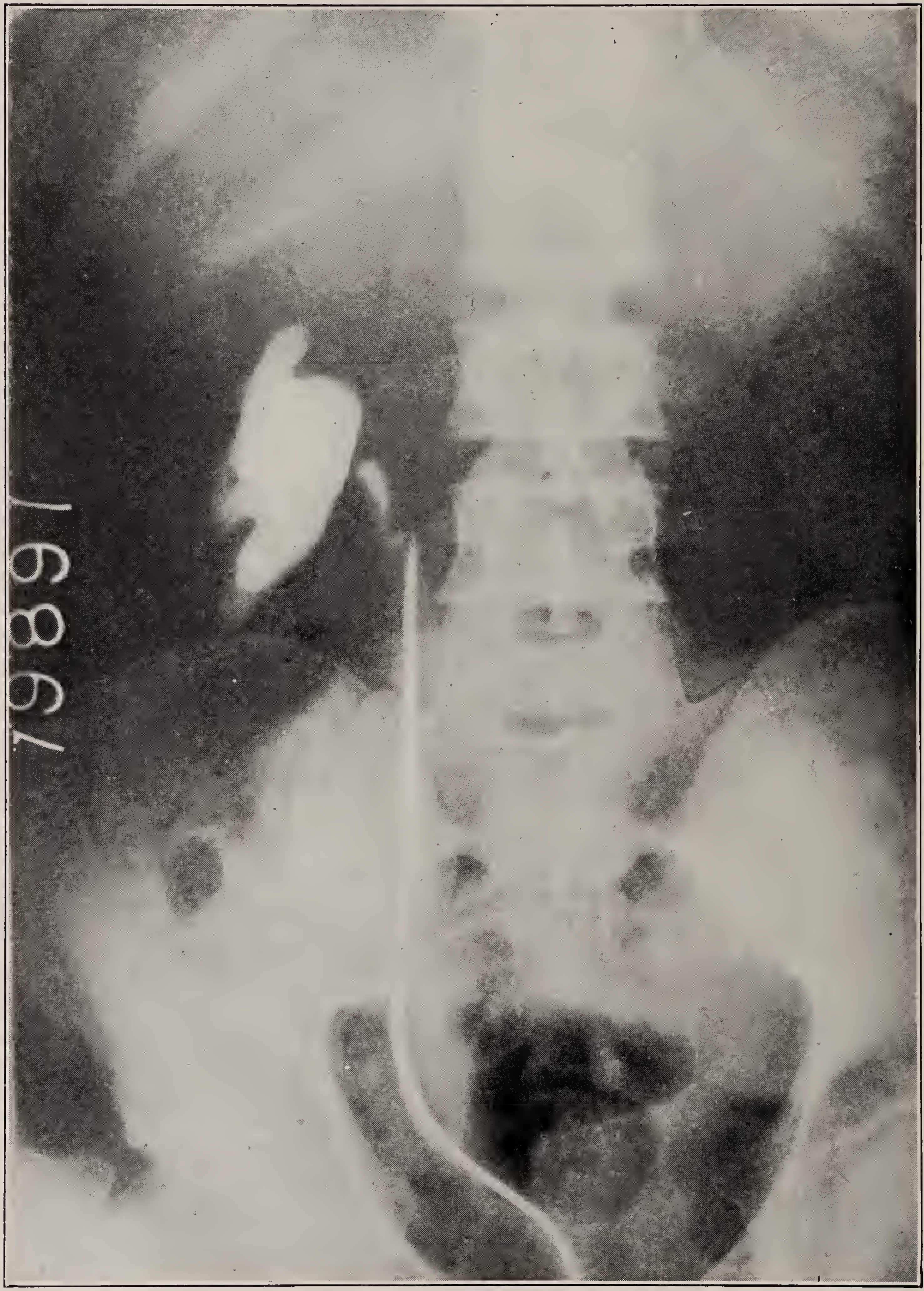

Fig. 13. Horizontal position. Hydronephrosis and ptosis with kinking of the ureter.

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FIG. 14. Vertical position demonstrating persistence of the kink and anchoring of the ptosed kidney probably due to perinephritic adhesions.

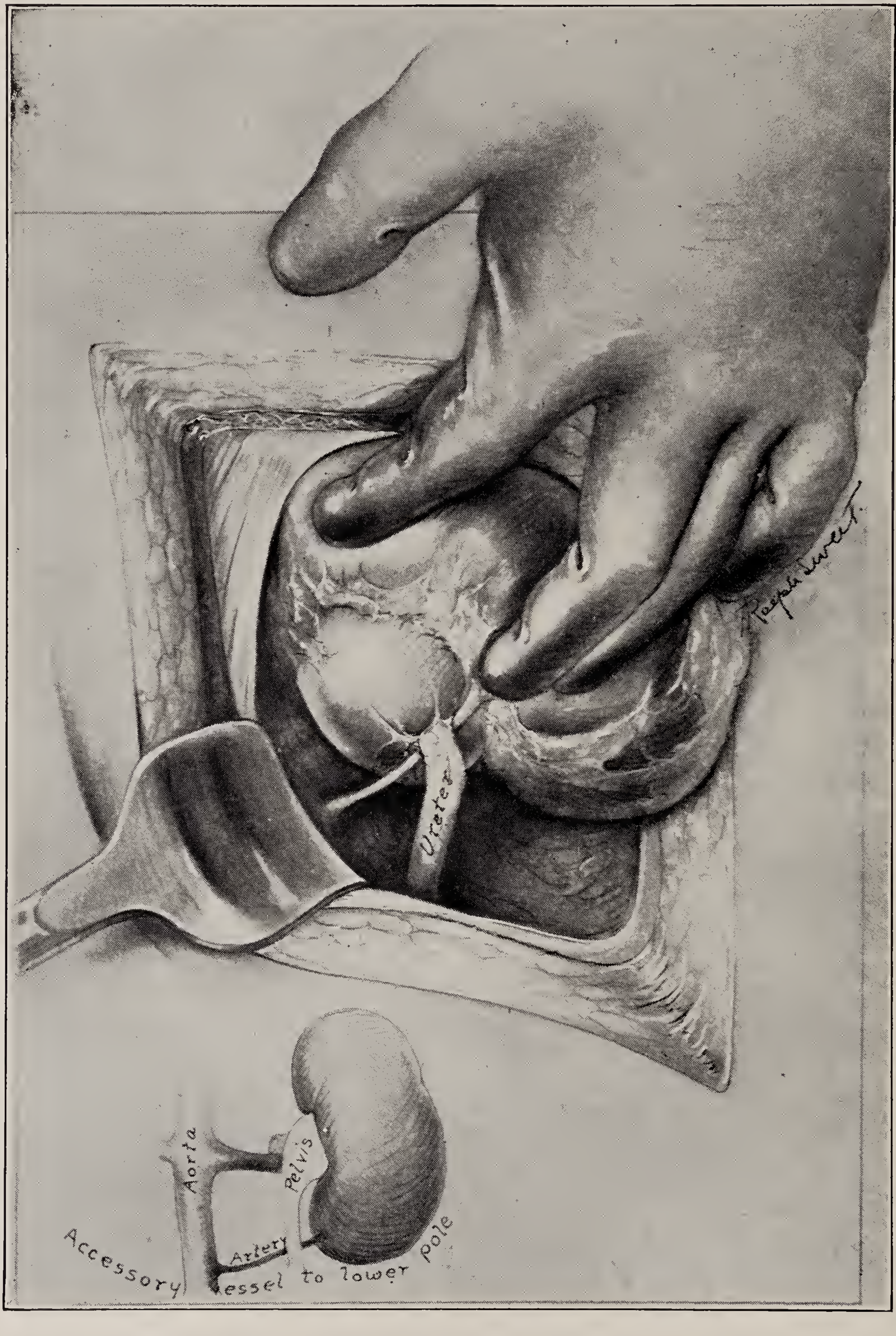

FIG. 15. Drawing of same case made at operation, showing aberrant vessel and stricture at the uretero-pelvic junction as the cause of the hydronephrosis.

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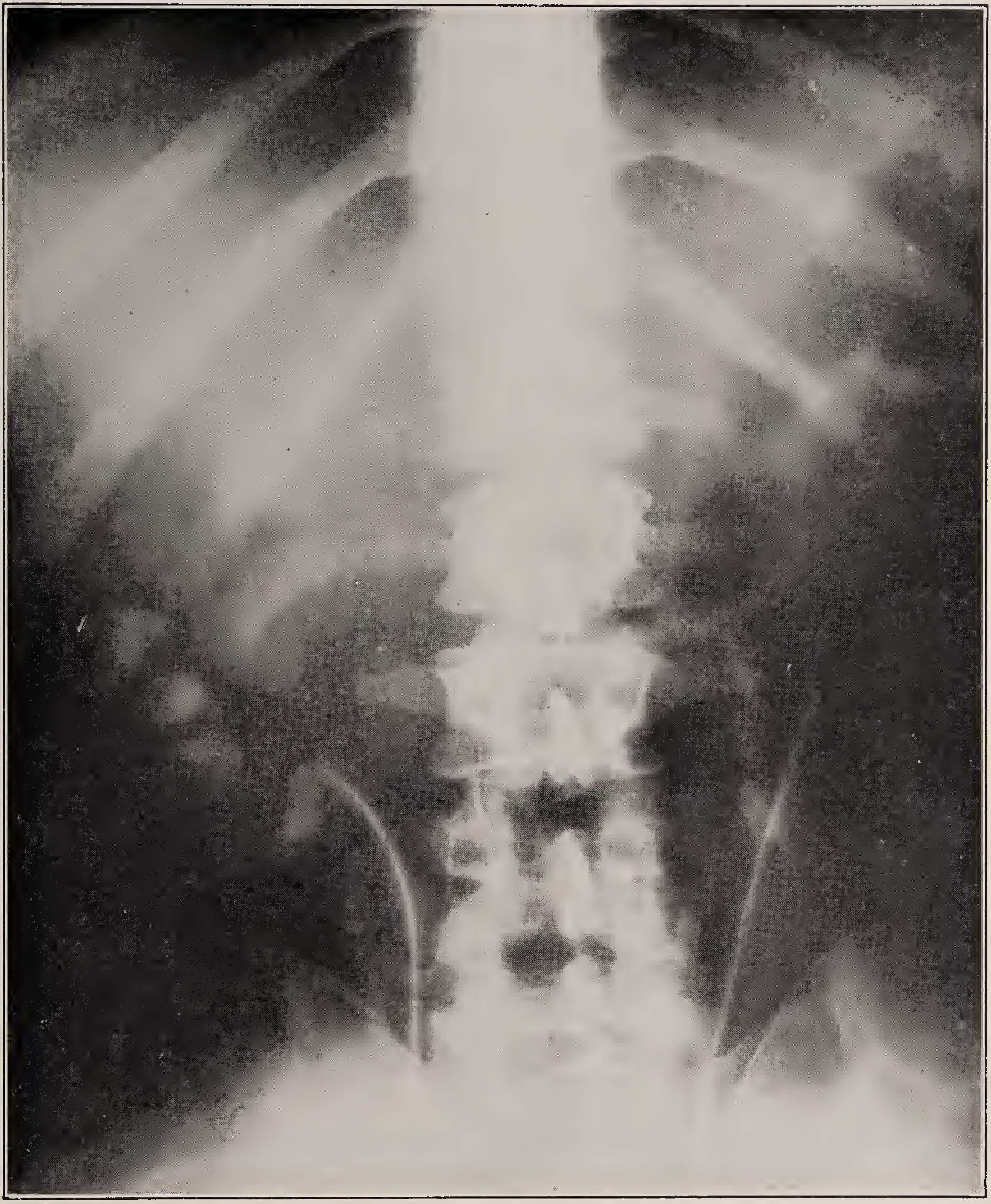

Fig. 16. Right pyelogram showing advanced hydronephrosis. Incomplete injection of the sac was due to large amount of pus contained in the pelvis.

responds to the level where the ureter crosses the ovarian or spermatic vessel. On the other hand the entire ureter may sag causing it to take a tortuous course.

In patients in whom the abnormally low position of the kidney causes no symptoms there is no stasis. In a certain percentage of cases, however, the following signs of back-pressure are demonstrated: The pelvis is enlarged; the major calyces are distended and become broader than normal and the minor calyces appear club-shaped due to the obliteration of the evagination of the papilla. This varies from slight dilatation of the pelvis and calyces to rather advanced hydronephrosis. Bazy, Maisonnet and other investigators are of the opinion that all malformations such as hydronephrosis are congenital and that the associated ureteral kink is not the cause but rather the result of this pre-existing malformation. This may be true in some instances, but the fact remains that the symptoms of movable kidney rarely if ever come on until after puberty and that in numerous cases relief is unquestionably obtained by fixation of the kidney and obliteration of the ureteral kink. These facts seem to

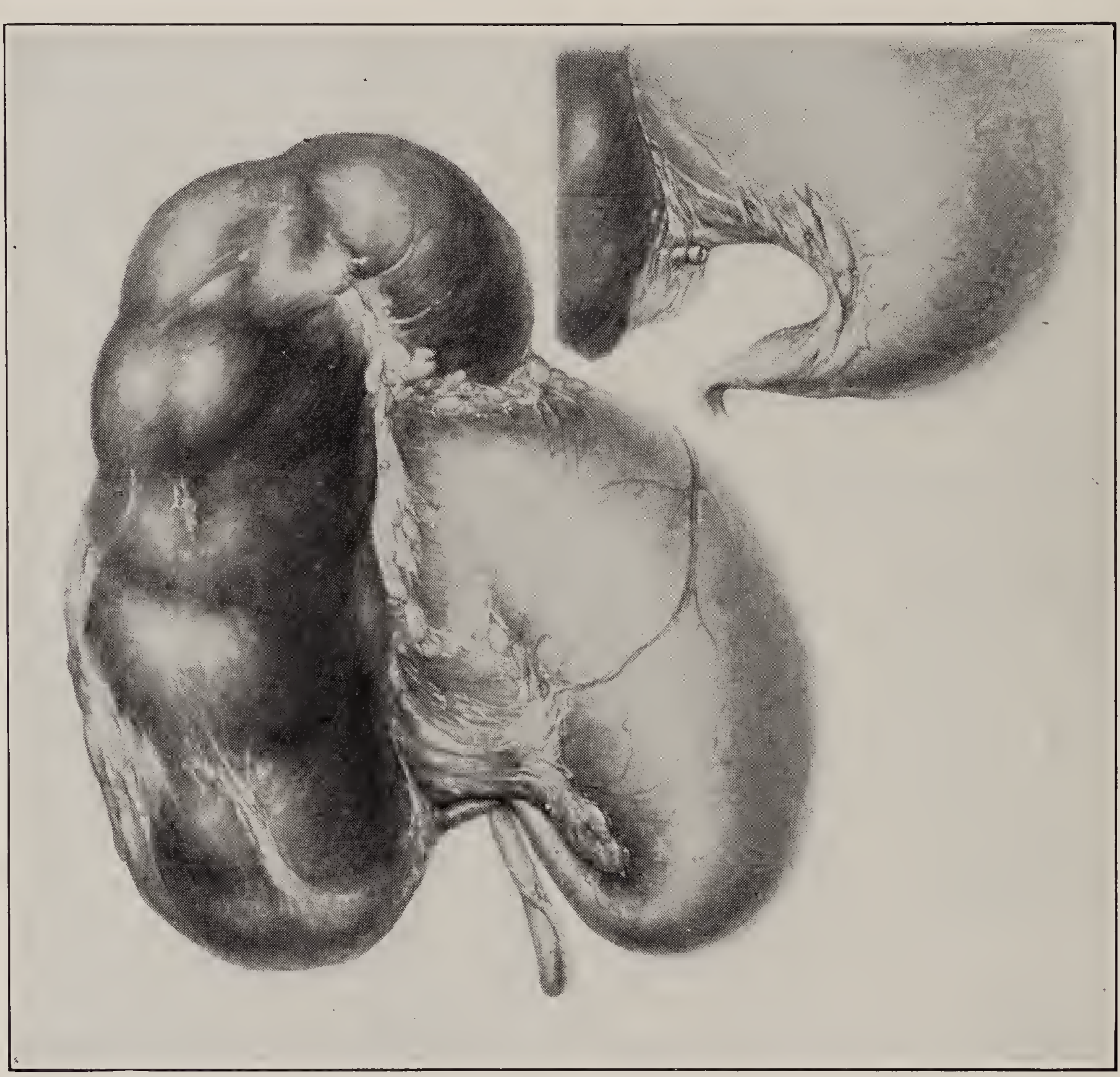

Fig. 17. Specimen removed at operation showing advanced hydronephrosis secondary to back pressure on the upper ureter caused by an aberrant artery supplying the lower pole.

indicate that increased mobility with kinking of the ureter are causes rather than results of hydronephrosis.

HYDRONEPHROSIS AND HYDRO-URETER

Hydronephrosis is a mechanical dilatation of the pelvis and calyces resulting from obstruction in the ureter, bladder or urethra. In making its diagnosis one should not be satisfied merely to confirm the dilated pelvis, but also to ascertain whether the cause of obstruction is a stricture, stone, kink of the ureter, aberrant blood vessel, extra-ureteral pressure, or the infra-vesical back-pressure produced by an enlarged prostate or a urethral stricture. In collecting the urine through the urethral catheter it flows away in a continual stream as if under pressure, giving one the mechanical suggestion of hydronephrosis. Unilateral polyuria may also cause increased outflow of urine; however, in these cases the pyelogram will show no significant enlargement of the pelvis and this distinguishes it from hydronephrosis. The amount of

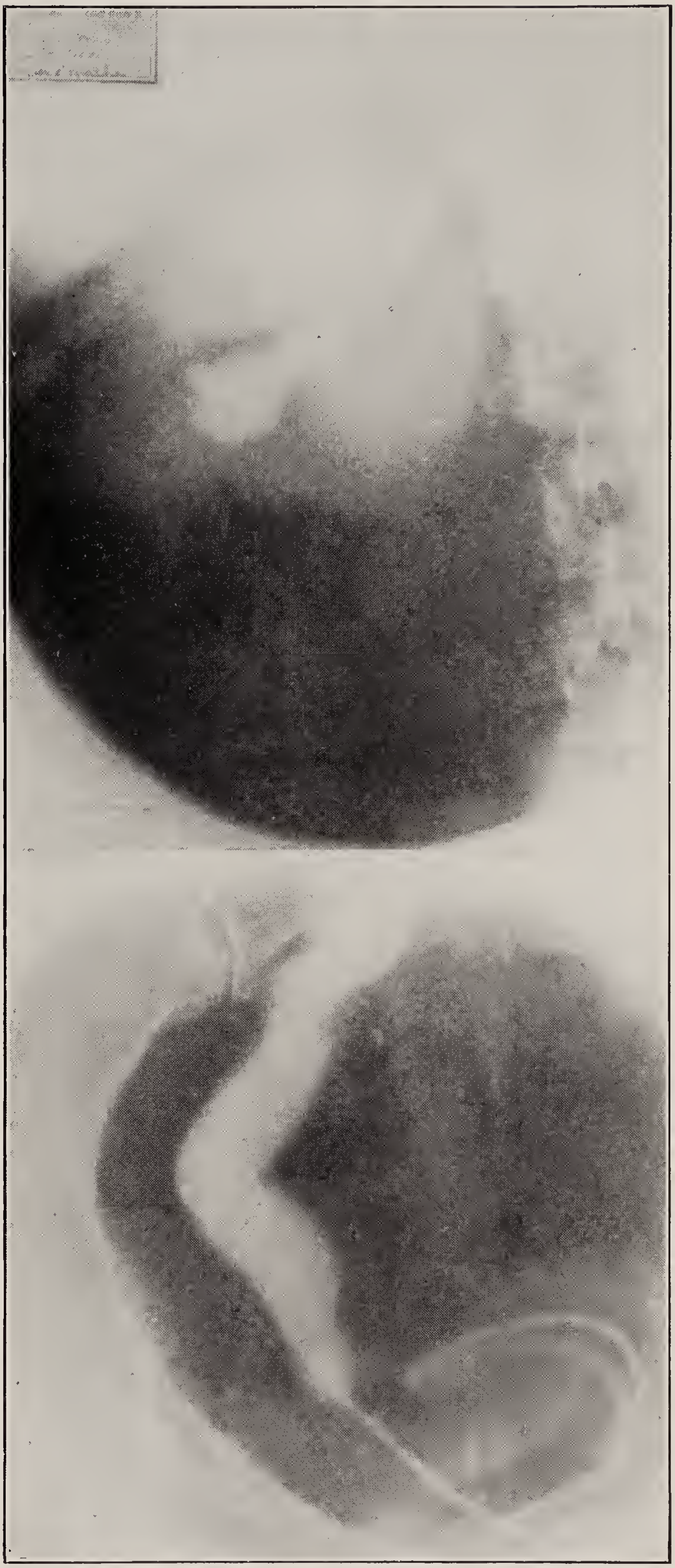

Fig. 18. Right uretero-pyelogram showing marked hydroureter and hydronephrosis.

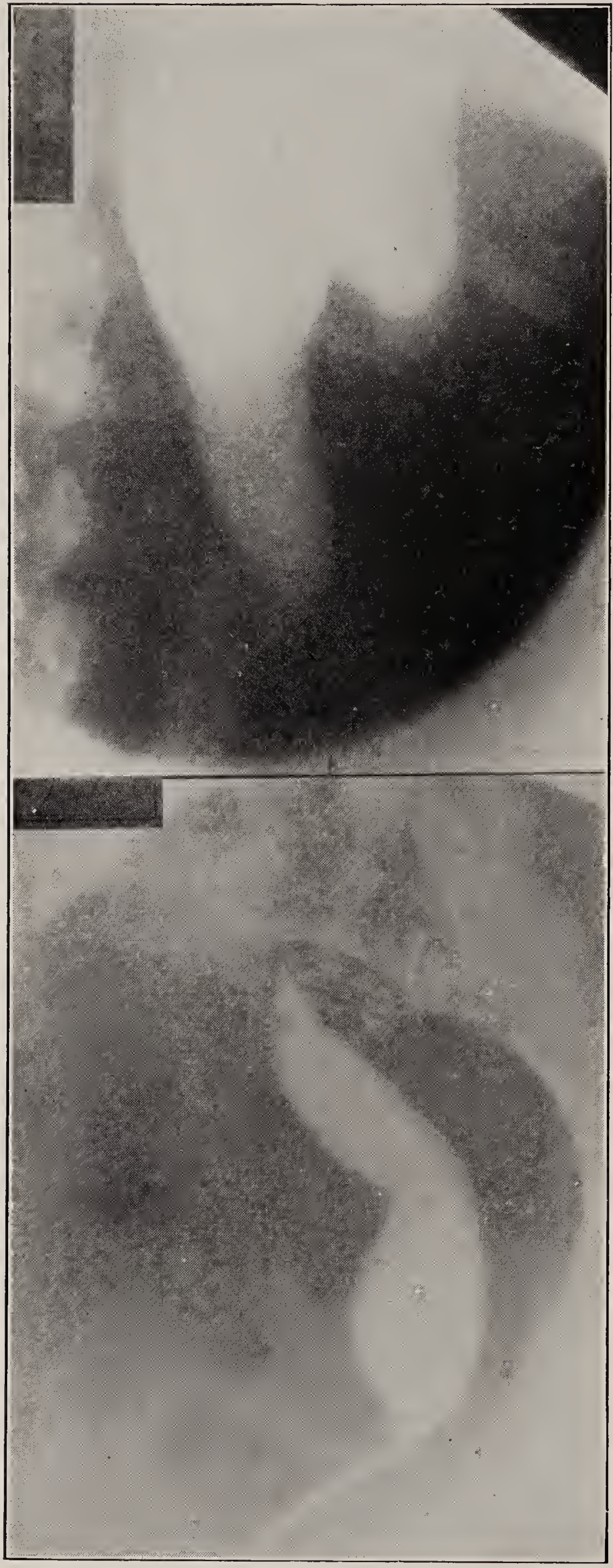

Fig. 19. Left uretero-pyelogram, more extensive hydroureter and hydronephrosis. (Patient had congenital stricture at ureteral orifice.)

urine retained in the pelvis can be measured and, if over 20 c.c., hydronephrosis is usually considered to be present. Likewise, one can determine the size of the hydronephrotic sac by noting the amount of solution required to fill the pelvis in making the film.

In early cases the minor calyces lose their cup-shape and become more or less club-shaped and the major calyces are broadened and flattened. In addition to this the pelvis becomes widened and the ureteropelvic junction occurs at a higher angle. As the pathological process progresses the ureter approaches the kidney at a higher level; the minor calyces become so dilated that only a vestige of them may be seen to remain or they may be entirely obliterated; the major calyces become broader and broader until finally they cannot be differentiated from the extremely widened pelvis with which they form a large hydronephrotic sac with almost entire obliteration of the parenchyma of the kidney.

Inflammatory processes due to tubercular and nontubercular infections of the kidney and to tumor formation may produce actual dilatation of the pelvis simulating hydronephrosis. These are irregular in outline and can be usually distinguished

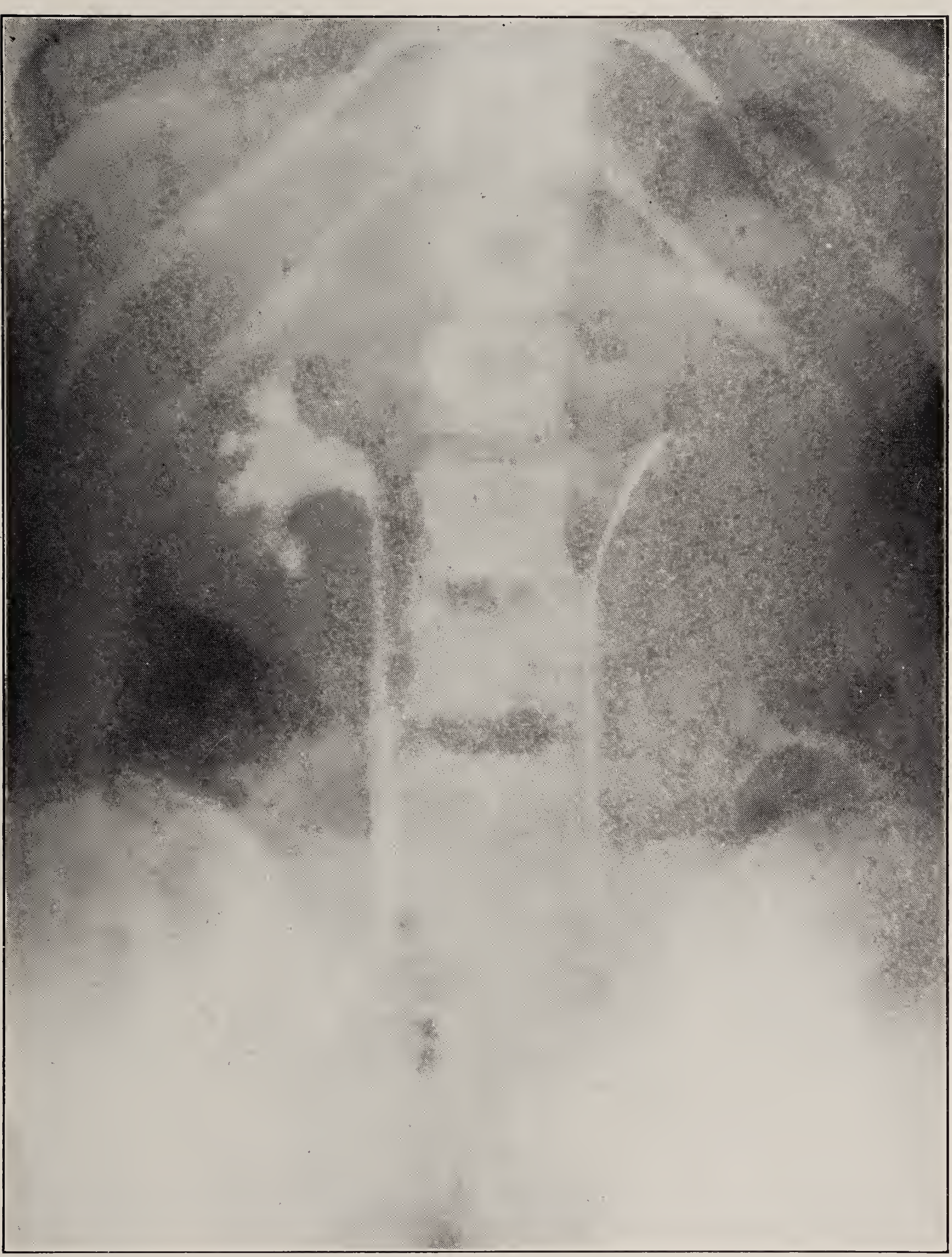

Fig. 20. Right pyelogram showing irregular extension of medium below inferior minor calyx suggestive of abscess. (Tubercle bacilli were recovered from right kidney urine.)

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from the type of hydronephrosis that is due to mechanical dilatation resulting from supra- or infra-vesical back-pressure.

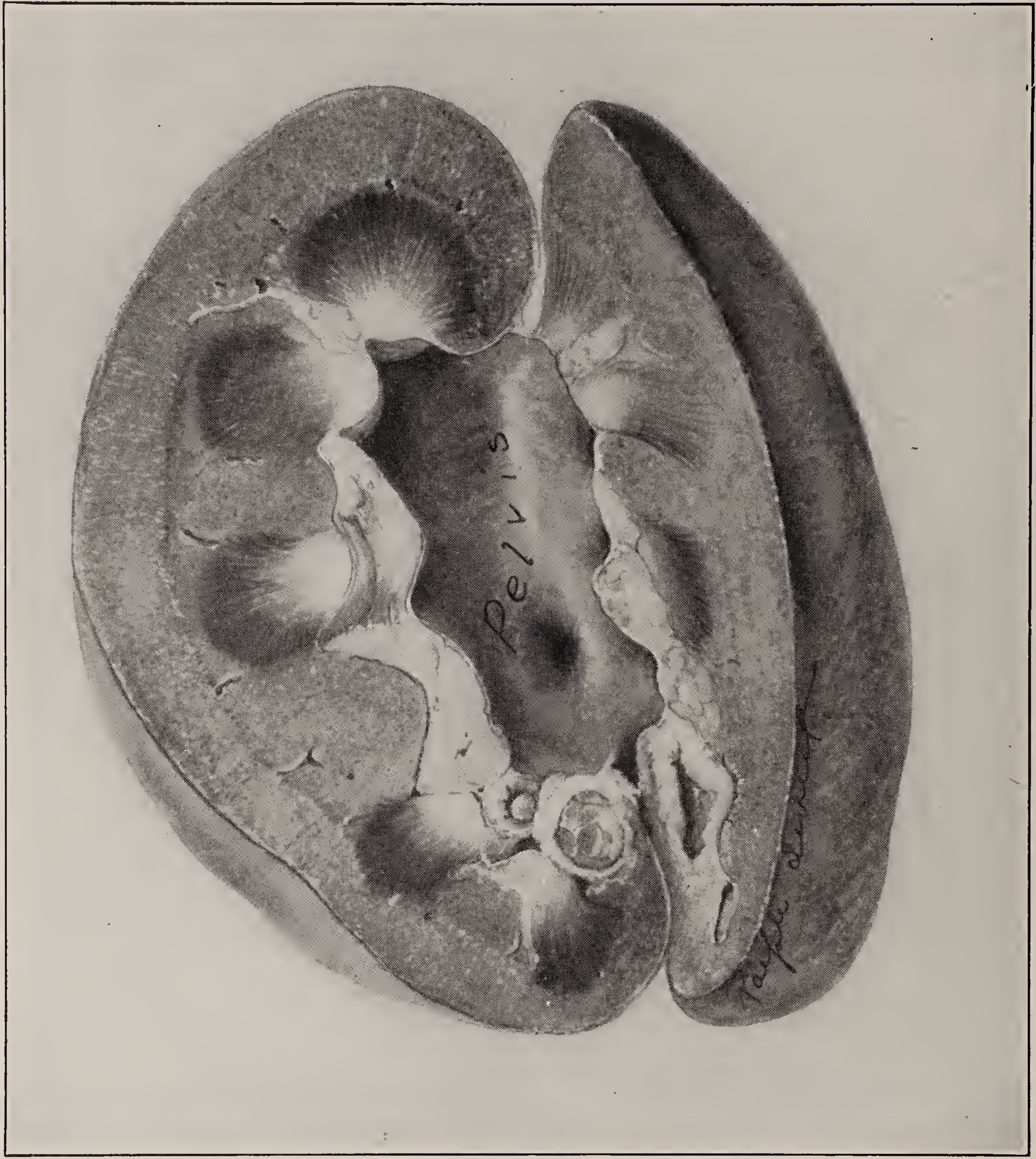

FIG. 21. Sagittal section of kidney of the same case removed at operation. Note tubercular abscess of lower pole which communicates with the pelvis.

TUBERCULOSIS OF THE KIDNEY AND URETER

In making a routine roentgenological examination of cases suspected of having renal tuberculosis, good plain films will often demonstrate the deposition of calcium salts which follows caseous destruction of the

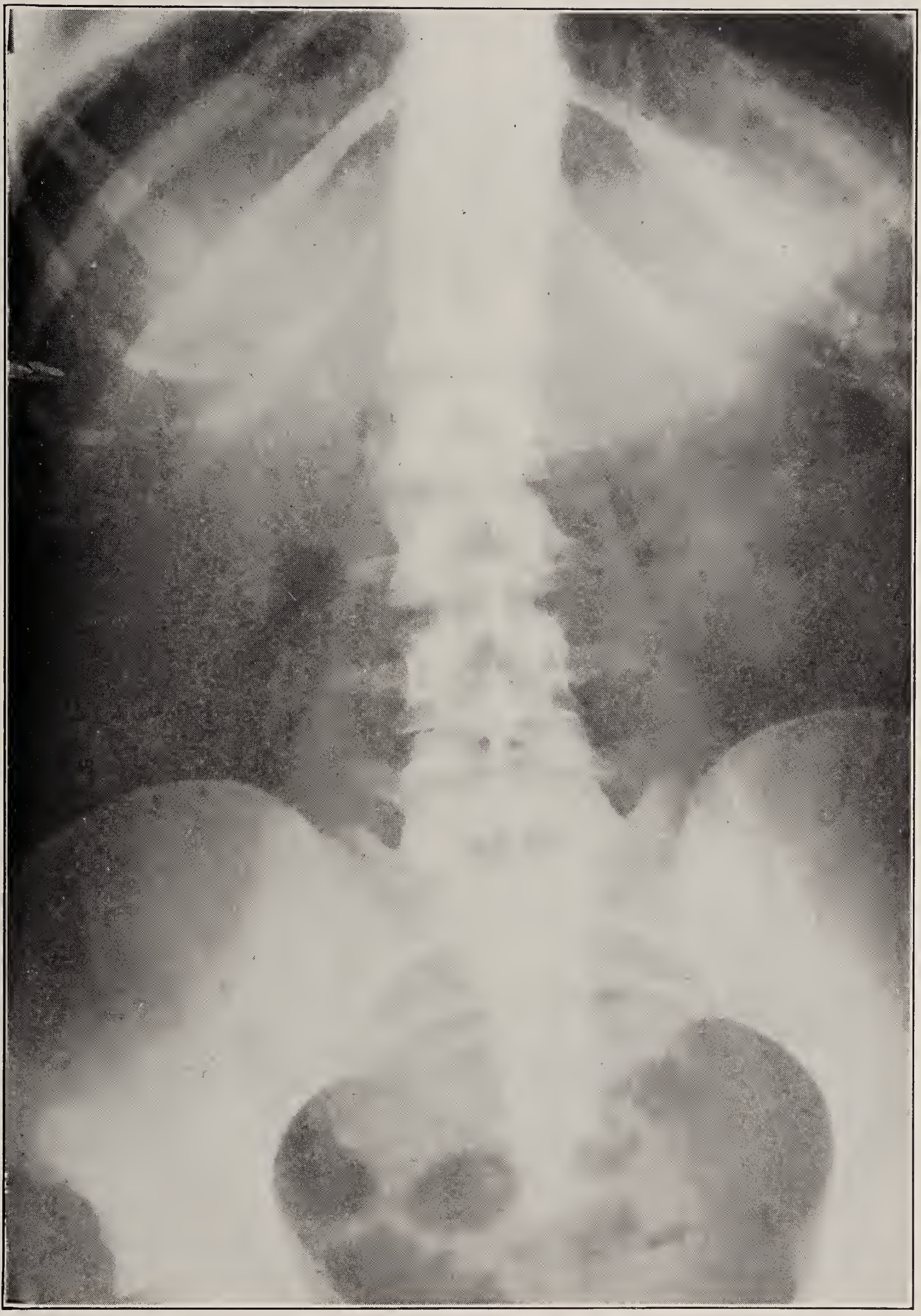

Fig. 22. Plain film showing enlarged left kidney and suspicious shadow on opposite side.

kidney. They are usually differentiated from stone formation by their more or less irregular " moth-eaten " appearance in which the density of the deposit is generally less marked and varies greatly in amount and shape. Certain multiple calculi may cast such hazy and dim outlines

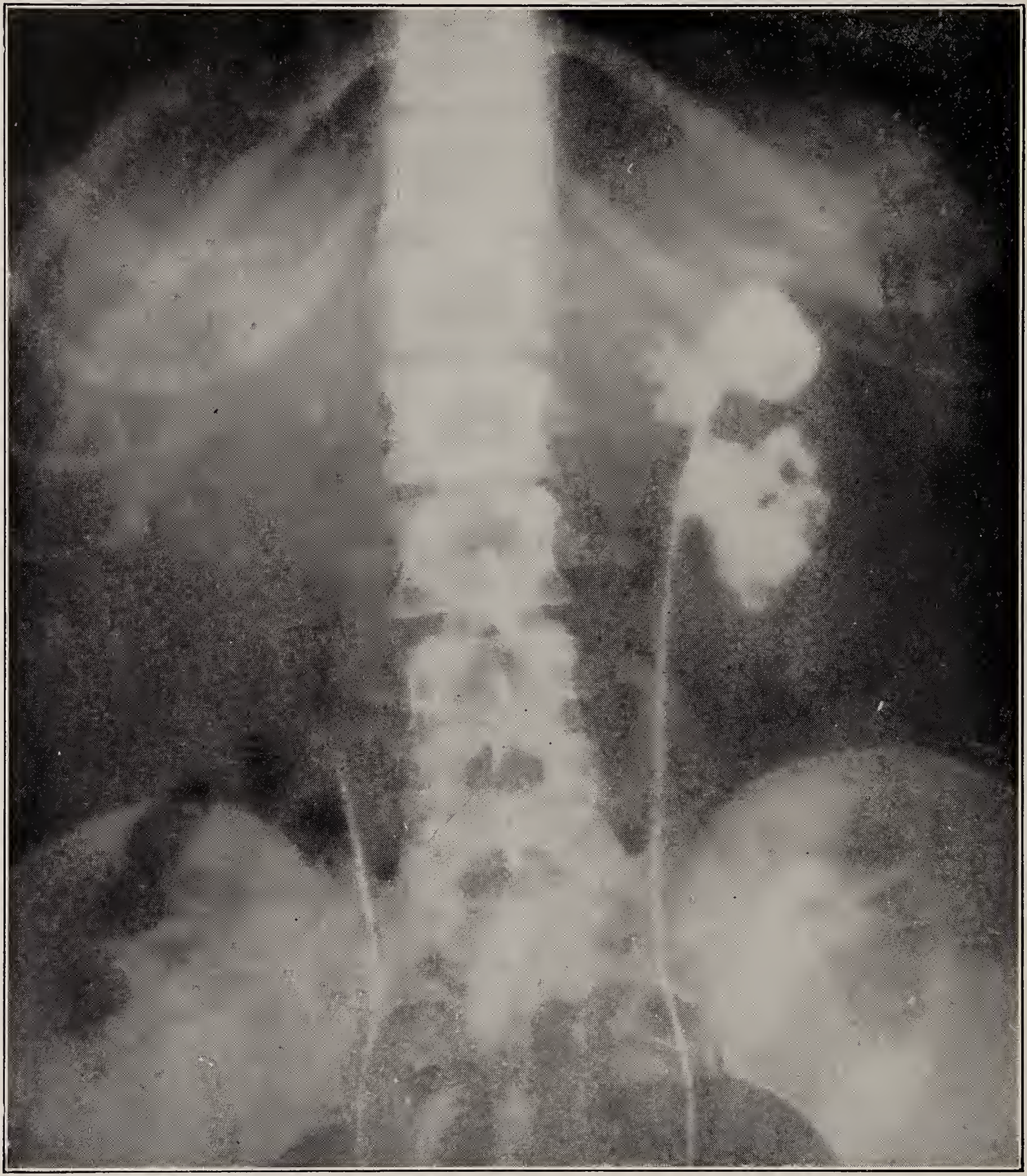

FIG. 23. Same case after injection showing large abscess communicating with upper major calyx and extending to the convex border of the kidney, and smaller abscess below. Tubercle bacilli were found in the left kidney urine.

that if one were to rely on the roentgenological diagnosis alone, they might be confused with tuberculosis. In a given case, presenting tubercular bacilli in which typical bilateral shadows are found, further examination should not be attempted and the patient spared a cystoscopic investigation. The employment of ureteropyelography in renal tuberculosis is to be resorted to when a complete functional study and cystoscopic examination including a careful search made by acid fast stains, culture and guinea pig innoculation of the urine collected from both kidneys, have left the diagnosis of a suspected case in doubt. In the very early stage there may simply be dilatation of the pelvis and calyces resembling the outline that one sometimes sees in pyelitis. As the pathological process progresses, the pelvis appears distorted and shaggy and as the papilla becomes involved definite destructive changes are seen to take place in the minor calyces, giving them a feathery appearance. These become

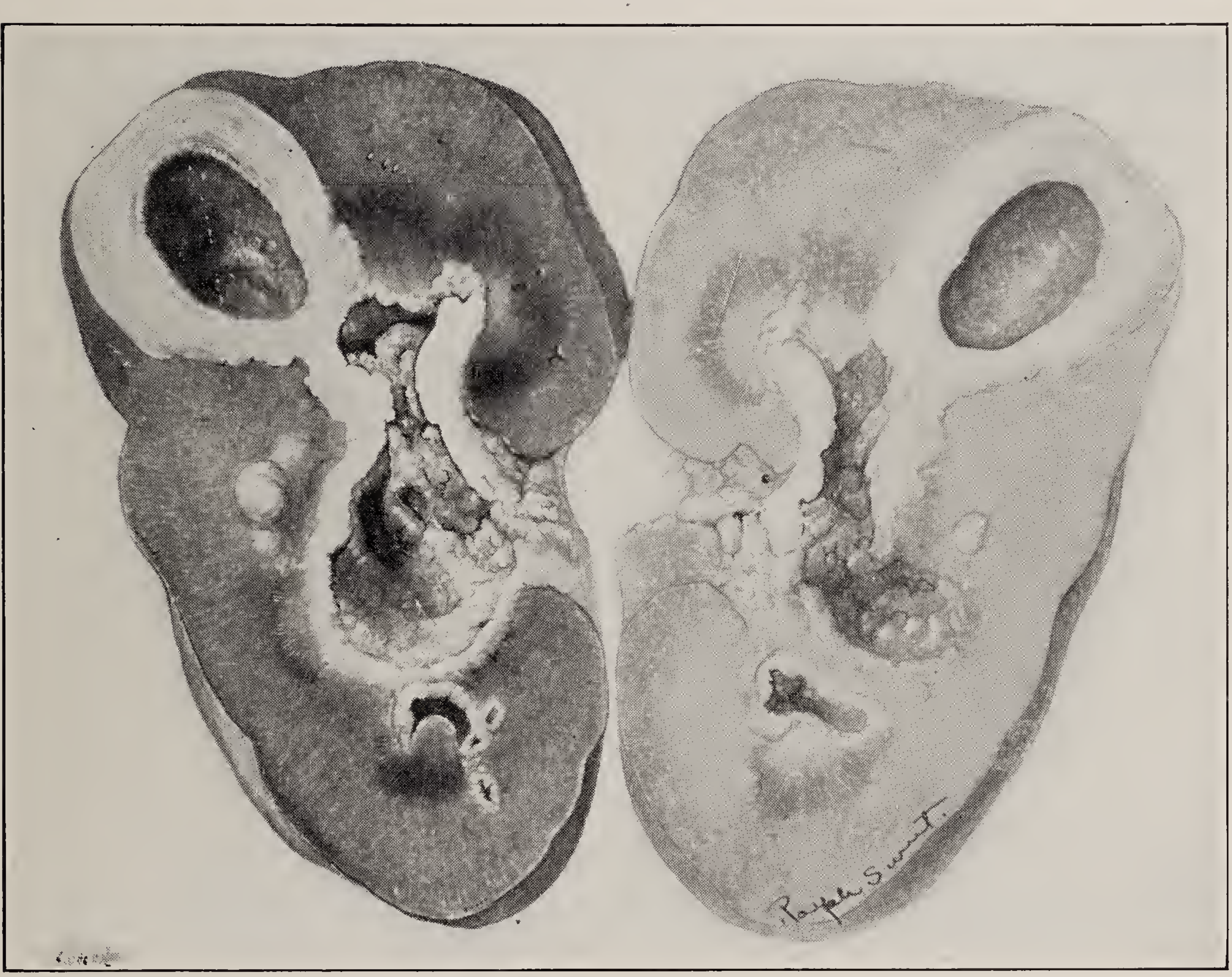

Fig. 24. Sagittal section of kidney removed at operation. Note large tubercular abscess of the upper pole, smaller abscesses of the lower pole, and marked distortion of the pelvis due to advanced tuberculosis.

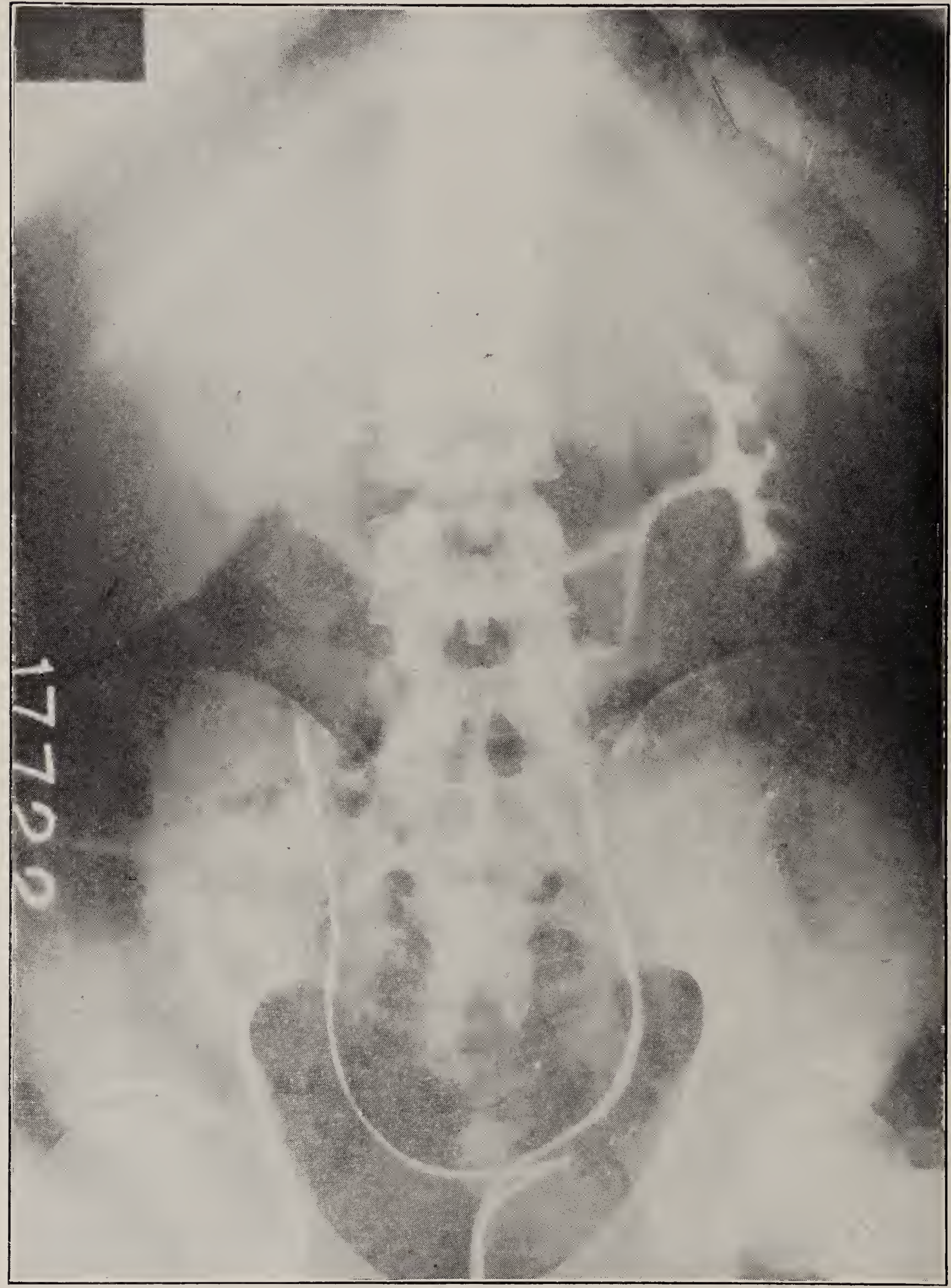

Fig. 25. Left pyelogram showing abscess in upper pole suggestive of tuberculosis. (Staphylococcus only recovered from urine, clinical relief obtained from routine pelvis lavage.)

irregularly dilated and more or less rectangular shaped, presenting uneven borders. Cavities varying in size and shape are sometimes demonstrated

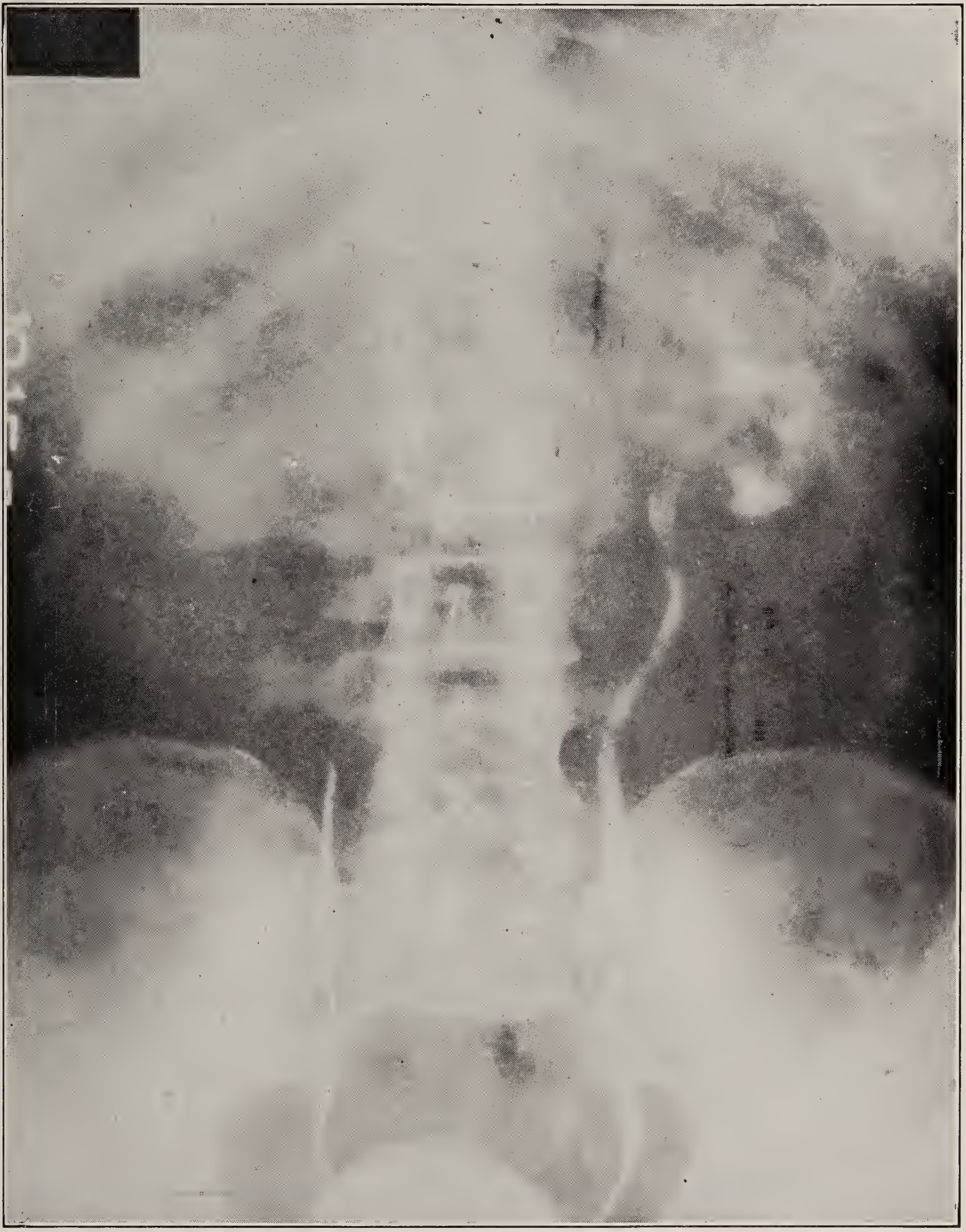

FIG. 26. Pyelogram demonstrating multiple renal abscesses. Although the kidney was repeatedly irrigated with rivanol (1 to 4000) the sodium iodide did not enter the abscesses satisfactorily on account of the large amount of thick pus contained therein.

in the adjacent parenchyma and are due to tuberculous ulceration and abscess formation. When the abscesses communicate with the pelvis the injected solution enters these, which may even extend to the convex border of the kidney. In cases in which the abscess contains considerable

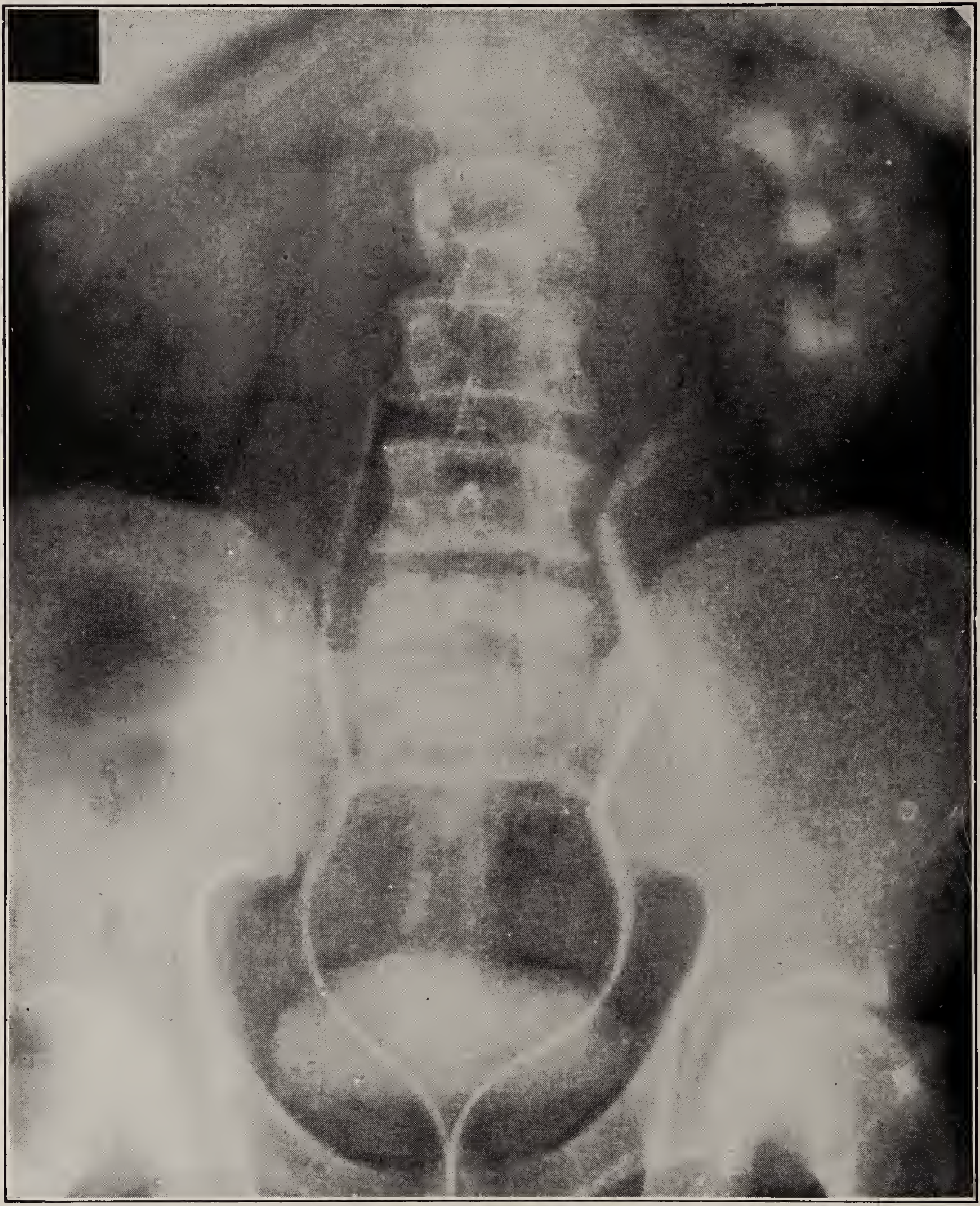

Fig. 27. Pyelogram repeated ten days later demonstrating that the solution has entered these abscesses more readily showing their size, shape and position.

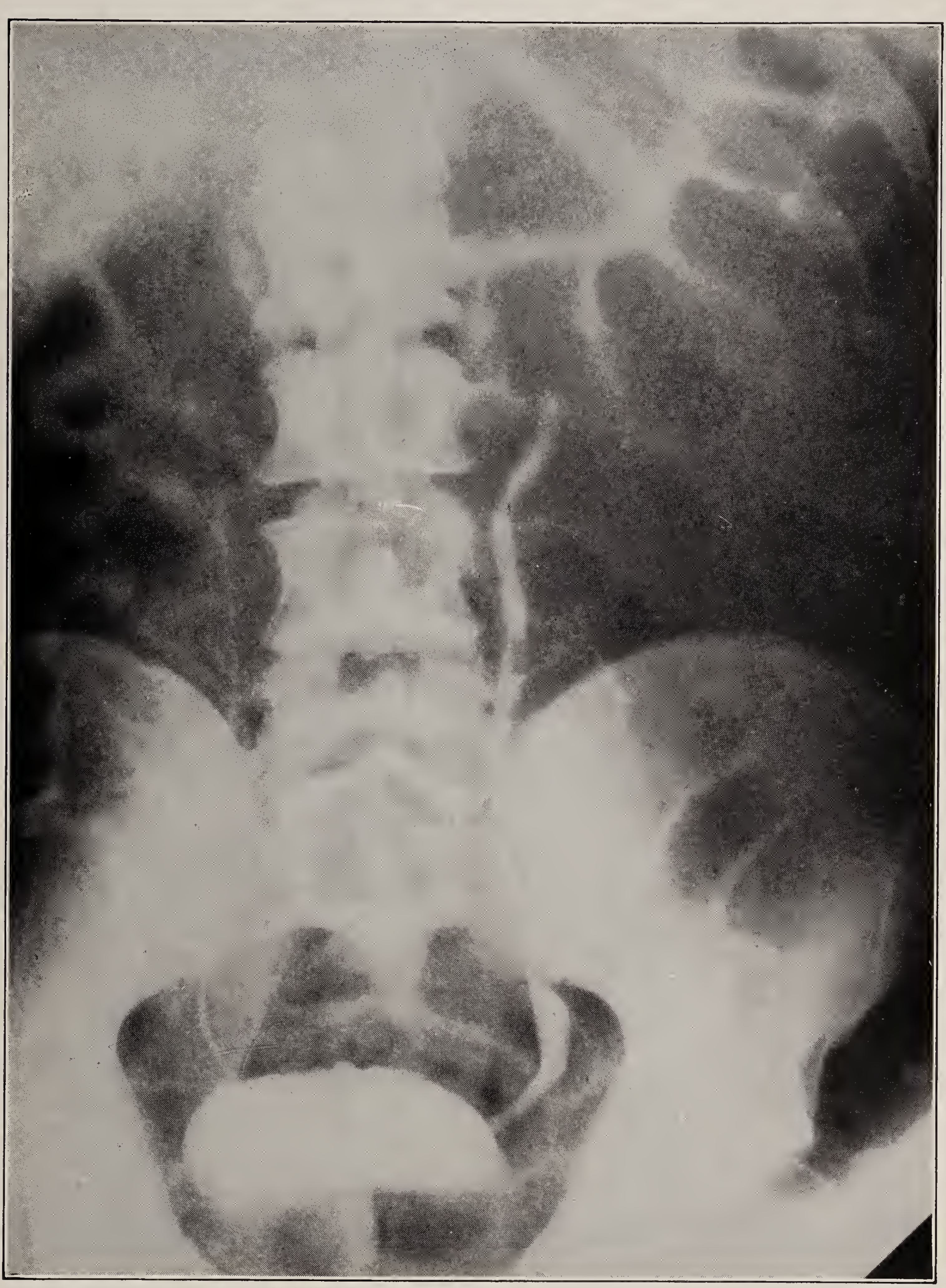

Fig. 28. Attempted left pyelogram showing injection of ureter only.

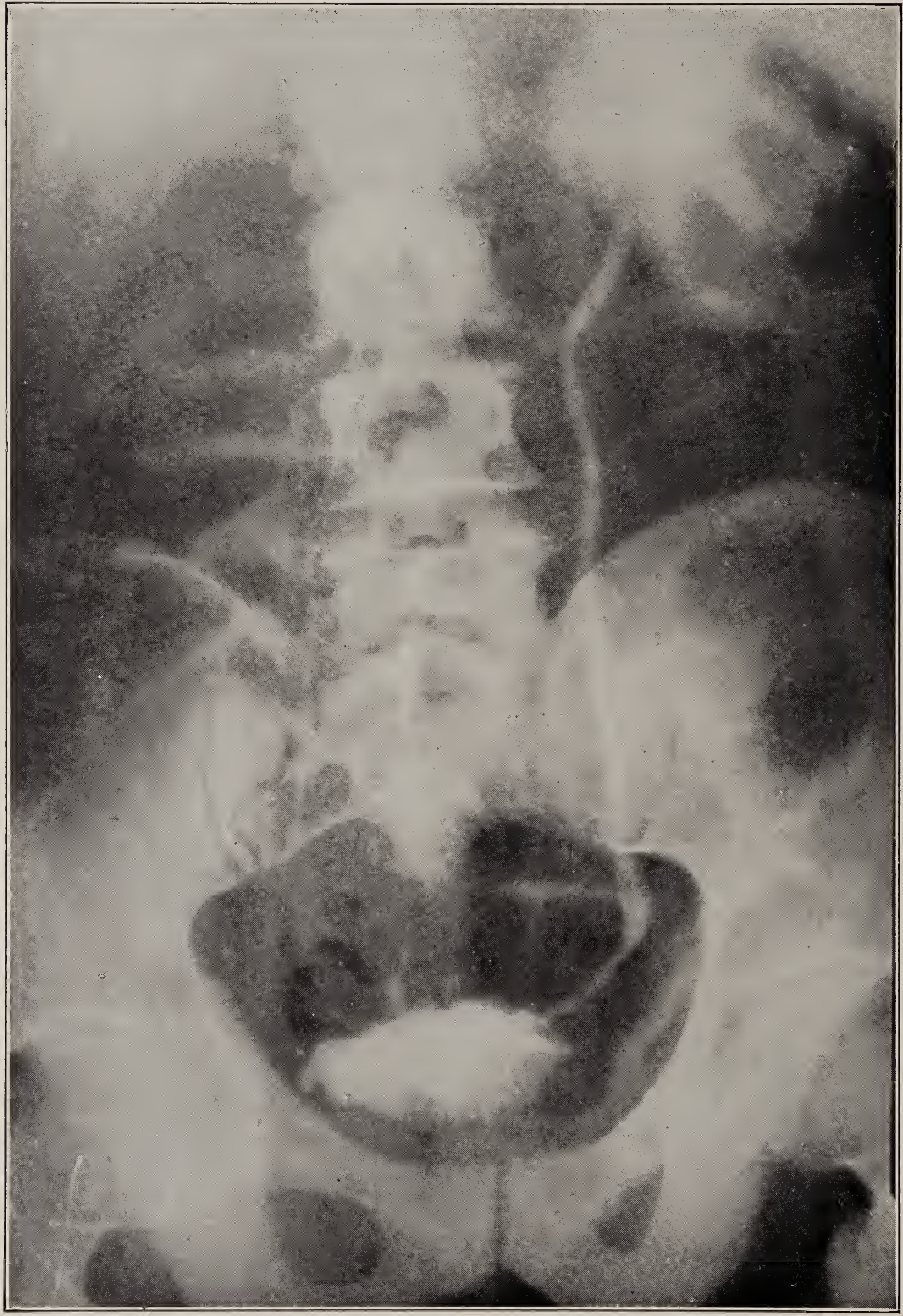

FIG. 29. Same case after placing patient in Trendelenburg position showing filling of hydronephrotic pelvis. This roentgenogram demonstrates the usefulness of this position which allows the kidney to drop back into its fossa, straightening out the ureter and allowing the iodide solution to enter the pelvis. VOL. 3. 1035.

caseous material, the injected opaque media may be prevented from entering it, but the irregular outline due to partial filling of such should make one suspicious of tuberculosis. Occasionally the outline of a necrotic area appears detached from the pelvis to which it may be connected by a very narrow or more or less invisible isthmus. In advanced cases of necrosis and massive degeneration of the kidney the entire cortex may have been destroyed permitting the injected material to more or less completely fill the entire kidney, giving one the picture of advanced pyonephrosis.

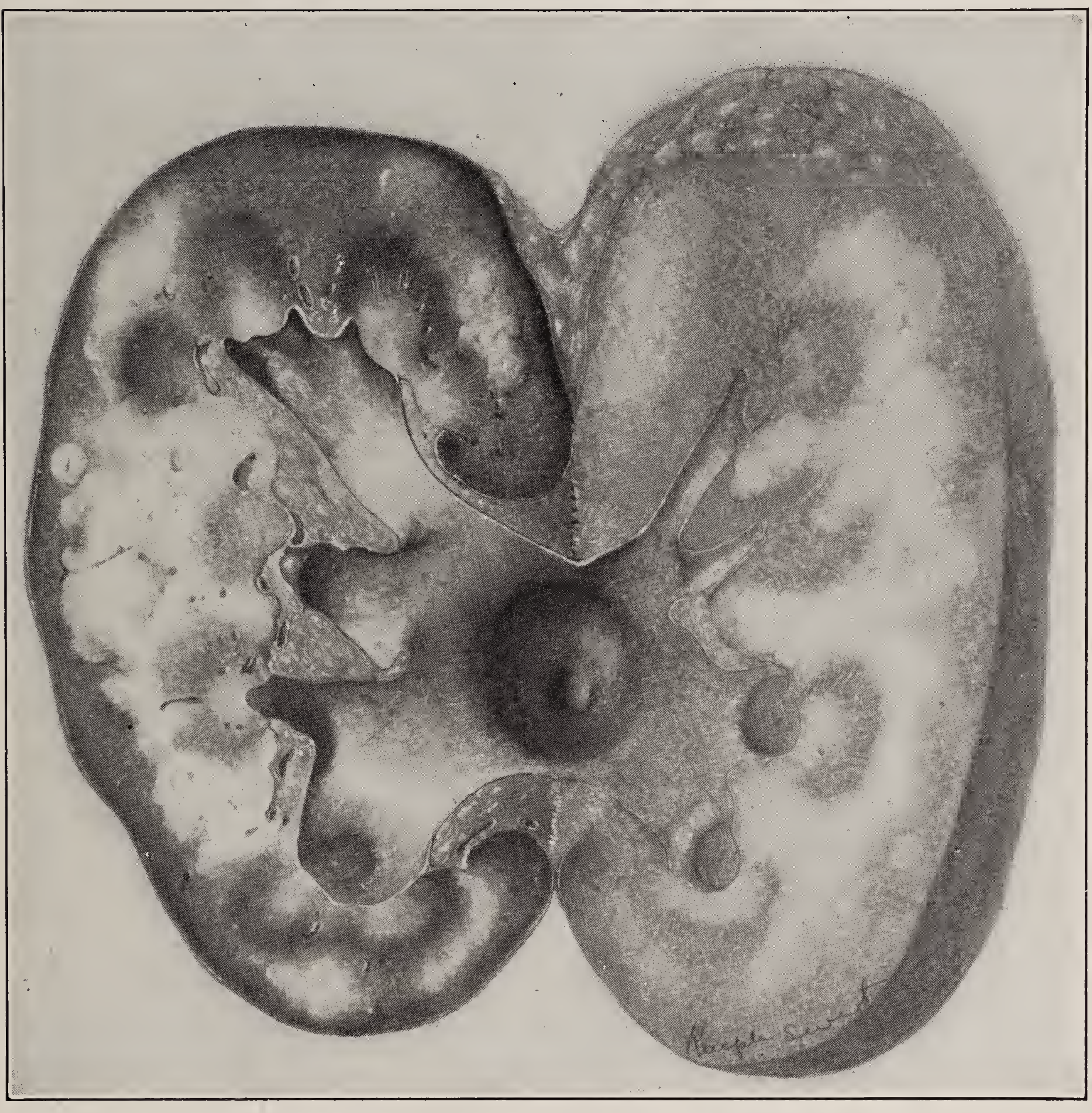

Fig. 30. Sagittal section of kidney of same case removed at operation. Note multiple abscesses which have destroyed the greater portion of the parenchyma of the kidney.

In certain types of renal tuberculosis various forms of hydronephrosis are observed. These may be due to the fact that tuberculosis has developed in a hydronephrotic kidney or has followed a tuberculous stricture of the ureter. In patients in whom tuberculosis has caused complete closure of the ureter it is impossible to pass a catheter and the diagnosis can only be made by interpretation of the plain films. Calcified abscesses in the kidney cast the characteristic mottled shadow of renal tuberculosis, but these must be differentiated from renal calculi or calcification of the neighboring lymph nodes.

PYONEPHROSIS

The success of obtaining a pyelogram portraying the different degrees of pyonephrosis varies with one's ability to inject the abscessed kidney which is more or less already filled with pus. Various pockets containing thick pus often cannot be readily emptied. Careful irrigation of the kidney will sometimes enable one mechanically to evacuate the interfering pus. If the parenchymal tissue is semi-necrotic irrigations will afford no aid. Furthermore, it is often impossible to ascertain complete filling of the pyonephrotic kidney as evidenced by the patient experiencing the sensation of pain because the destructive processes have done away with this diagnostic point. In order to ascertain the size of the pyonephrotic kidney one must also note the amount of solution required to fill the kidney as noted in the burette. One must also employ other signs obtained by cystoscopy, e.g. the obtaining of pure pus from a kidney with reduced function. The ureter may or may not be dilated depending on whether or not there is any obstruction along its course.

PYELITIS

The roentgenographic diagnosis of pyelitis is a matter of considerable uncertainty; however, kidneys involved by chronic infections, such as pyelitis, pyelonephritis, et cetera, may present a moderate degree of dilatation of the pelves and calyces or, on the contrary, a condition of spasm. These dilatations differ from those of hydronephrosis, which result from back pressure, in the fact that the pelvis, minor and major calyces are irregularly dilated. As the inflammatory process advances dilatation of the calyces becomes more marked, but the pelvis fails to dilate in equal proportion. This latter point is regarded to be suggestive of dilatation due to inflammatory changes rather than to mechanical back pressure. The ureter may be more or less dilated, sinuous or kinked depending on the pathological lesions contained therein.

KIDNEY ABSCESS

The presence of kidney abscesses can be suspected by the general signs and symptoms characteristic of this lesion. In cases in which the abscess has penetrated the pelvis the injected solution readily enters it casting a distinct shadow. When the abscess is limited to the cortex and has not penetrated the pelvis it cannot be so easily demonstrated. In a certain percentage of cases, it may cause bulging of the convex border of the kidney giving one a more or less abnormal kidney outline which may be noted in the plain film or it may press upon and cause elongation of one of the major calyces. It is well to thoroughly irrigate the kidney in order to evacuate the pus from the abscess pocket and allow the opaque solution to enter.

LITHIASIS OF THE KIDNEY AND URETERS

One of the earliest applications of x-ray diagnosis to lesions of the urinary tract was applied to renal calculi. Plain x-ray films carefully taken will reveal suspected calculi in the great majority of cases. The employment of the opaque ureteral catheter with the aid of stereoscopic films will demonstrate whether or not a suspected calculus is located in the ureter or kidneys. The employment of ureteropyelography allows one definitely to locate the suspicious shadow, determine the amount of back pressure it has caused and to point out its actual location in the kidney or ureter. It also allows us to rule out calcified deposits in neighboring lymph glands, calculi in the gall-bladder, and phleboliths, so often found in the region of the lower ureter.

In noting suspicious shadows it is necessary that they be located in the kidney region between the level of the 11th thoracic and the 3rd dorsal vertebrae. They should have a definite relation to the shadow cast by the kidney as noted in the plain film, but in order to determine their position relative to the pelvis itself it is necessary to inject the pelvis.

The following technique gives one a fairly accurate method of determining the presence of urinary calculi. Plain plates are taken and if any suspicious shadows are seen opaque wax-tipped catheters are inserted and their relation noted to the same. The wax tip is carefully inspected for characteristic scratches or " gouges ". The pelvis and ureter are then injected, localizing the shadow. The catheter is then withdrawn and an additional plate taken. If the ureteral calculus is producing retention the opaque solution is seen to be retained above the point of obstruction. After the greater portion of the solution has been drained off a final film

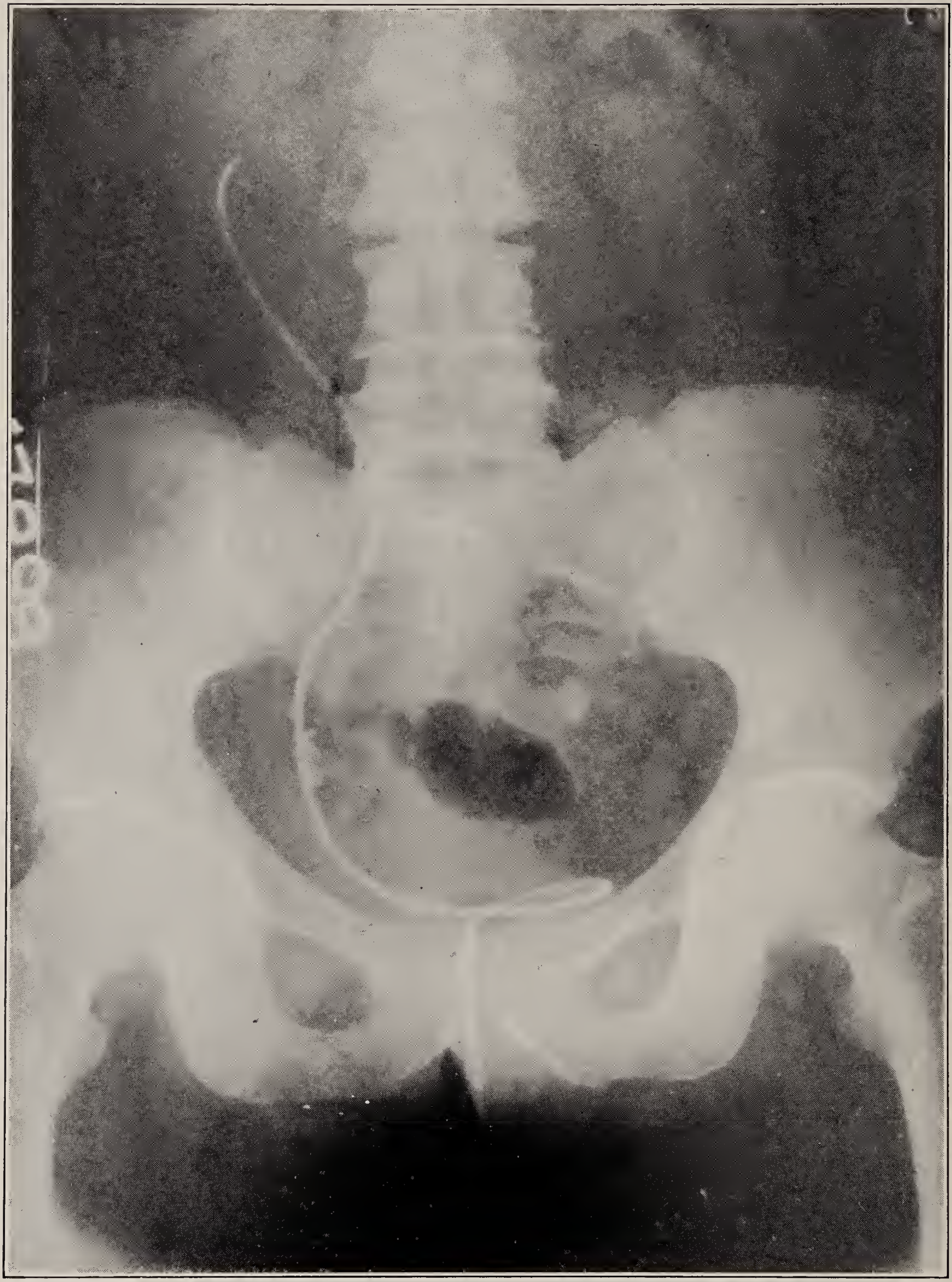

FIG. 31. Bilateral ureteral calculi, stones lying in the lower ureters. (With complete obliteration of the left ureter below the calculus.)

is taken and a calculus which is either not opaque to the x-ray or only faintly opaque may appear as a negative or faintly positive shadow.

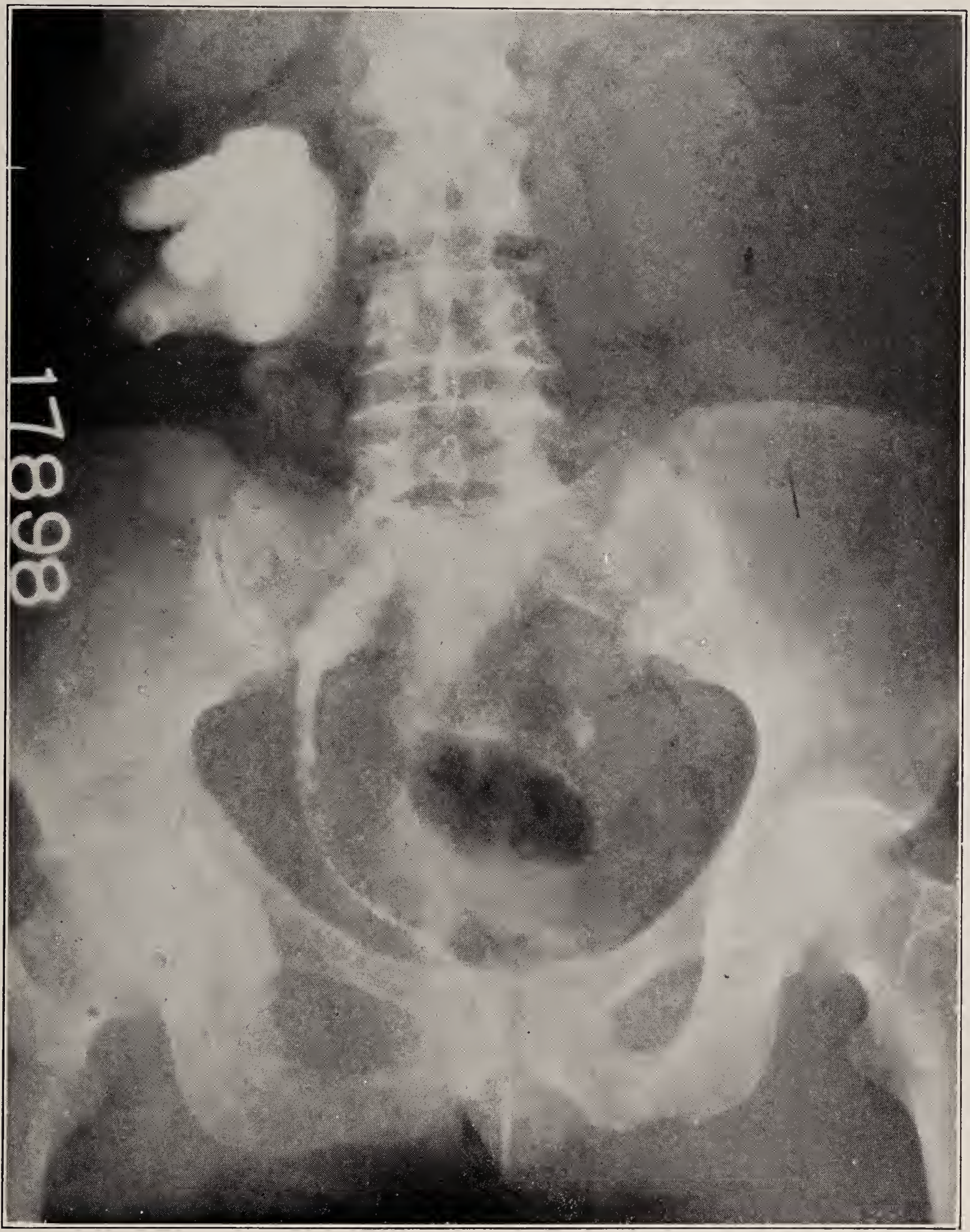

Fig. 32. Same case after injection showing right hydronephrosis and hydroureter. (Uretero-nephrectomy on left side and uretero-lithotomy on the right side with relief.)

By employment of ureteropyelography the position of a stone in the kidney can actually be demonstrated, and its surgical approach determined, be it by pyelotomy or nephrotomy.

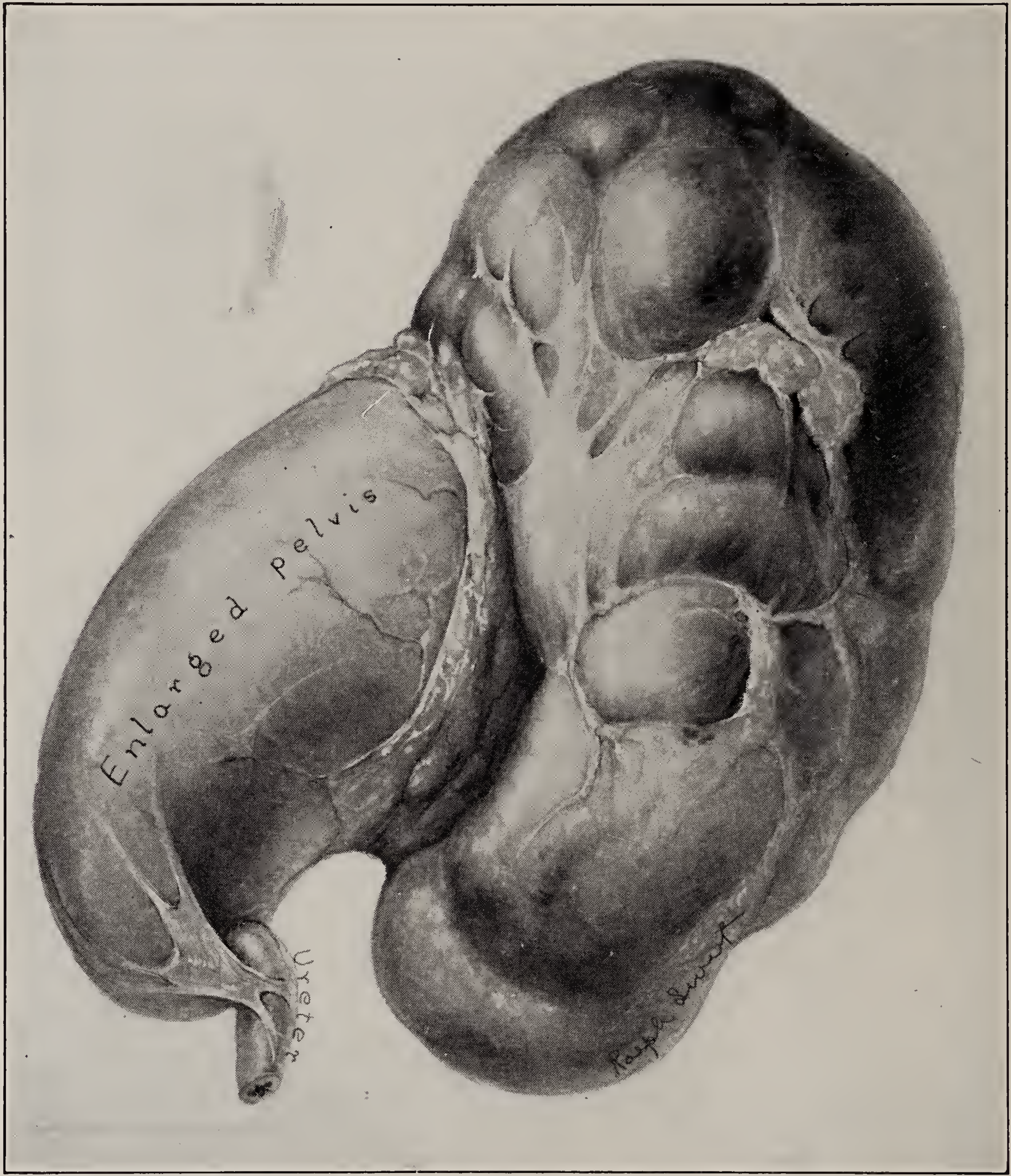

FIG. 33. Same case showing large hydronephrotic sac on right side removed at operation.

In spite of the most modern improvements in technique in the taking of x-rays, a small percentage of urinary stones is overlooked. These occurred in 1.7 per cent. of 114 cases recently studied in the urological service of Saint Mary's Hospital, San Francisco. As early pointed out by Béclère these were of the uric acid variety.

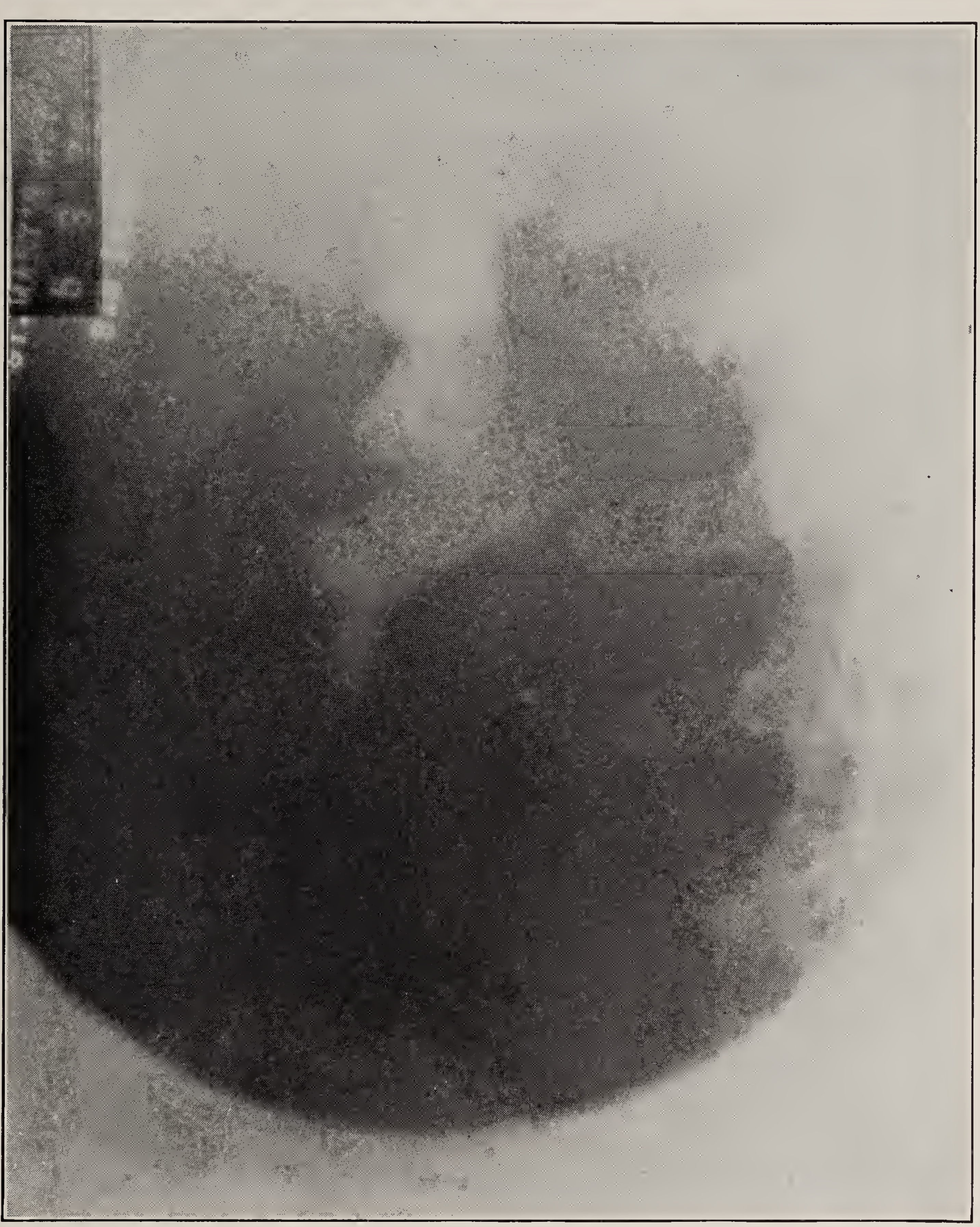

Fig. 34. Right pyelogram showing slight hydronephrosis secondary to ureteral stone. Stone not seen in this film.

Improvements in technique of locating stone in the kidney during operation. Although the exact position of kidney calculi can be usually accurately determined by the films taken prior to operation, by needling,

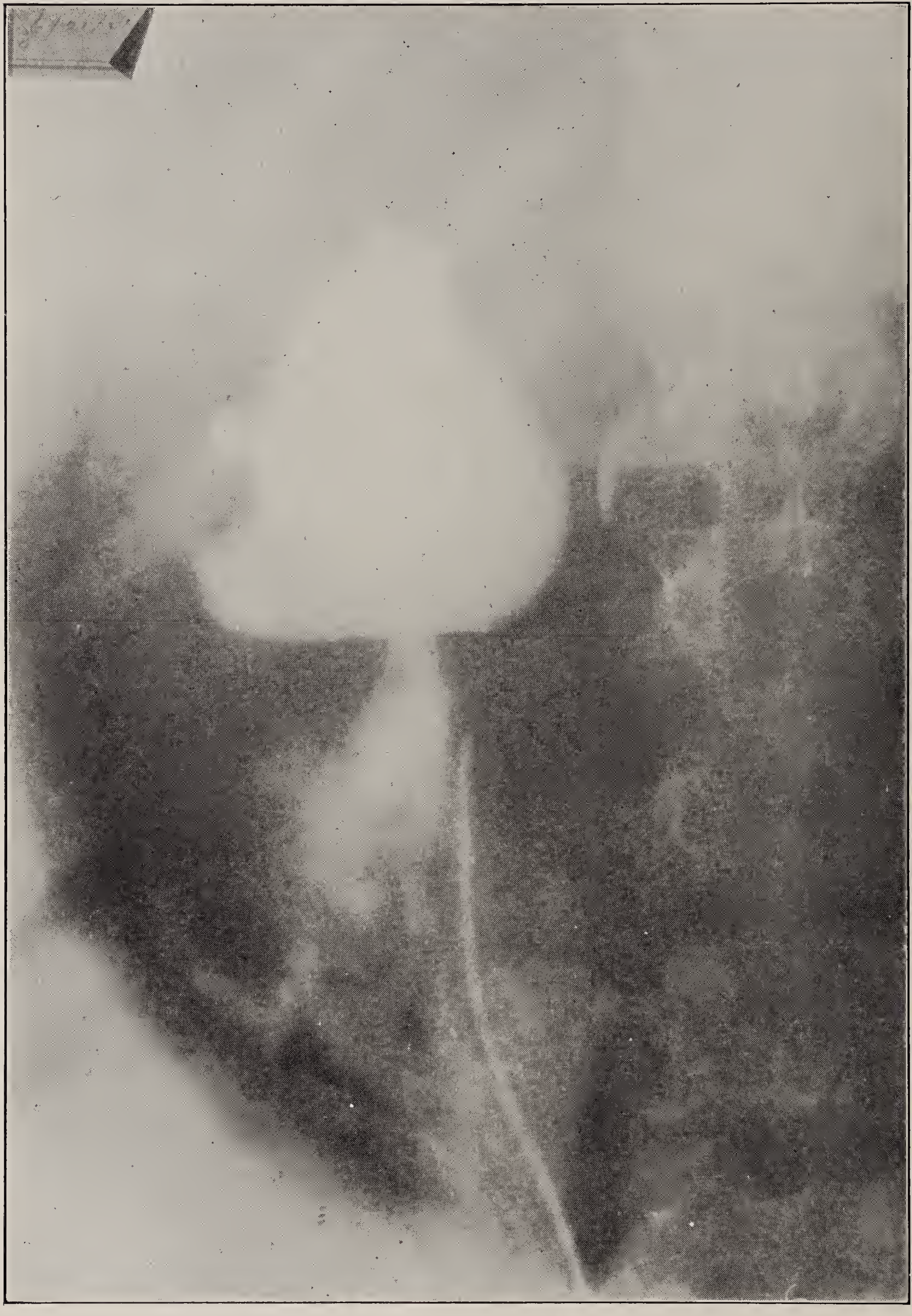

FIG. 35. Same case six weeks later showing increase in the degree of dilatation of the pelvis, and extravasation of the medium caudad and retro-peritoneally. Whether the rupture of the pelvis was secondary to over-injection or to primary disease in the wall of the pelvis is not certain. VOL. 3. 1035.

or by palpation at the time of surgical exposure of the kidney, there remains a certain group of cases in which it is quite difficult to locate the stone. Braasch and Carmen were among the first to recommend and employ a roentgenographic study of the kidney at the time of operation

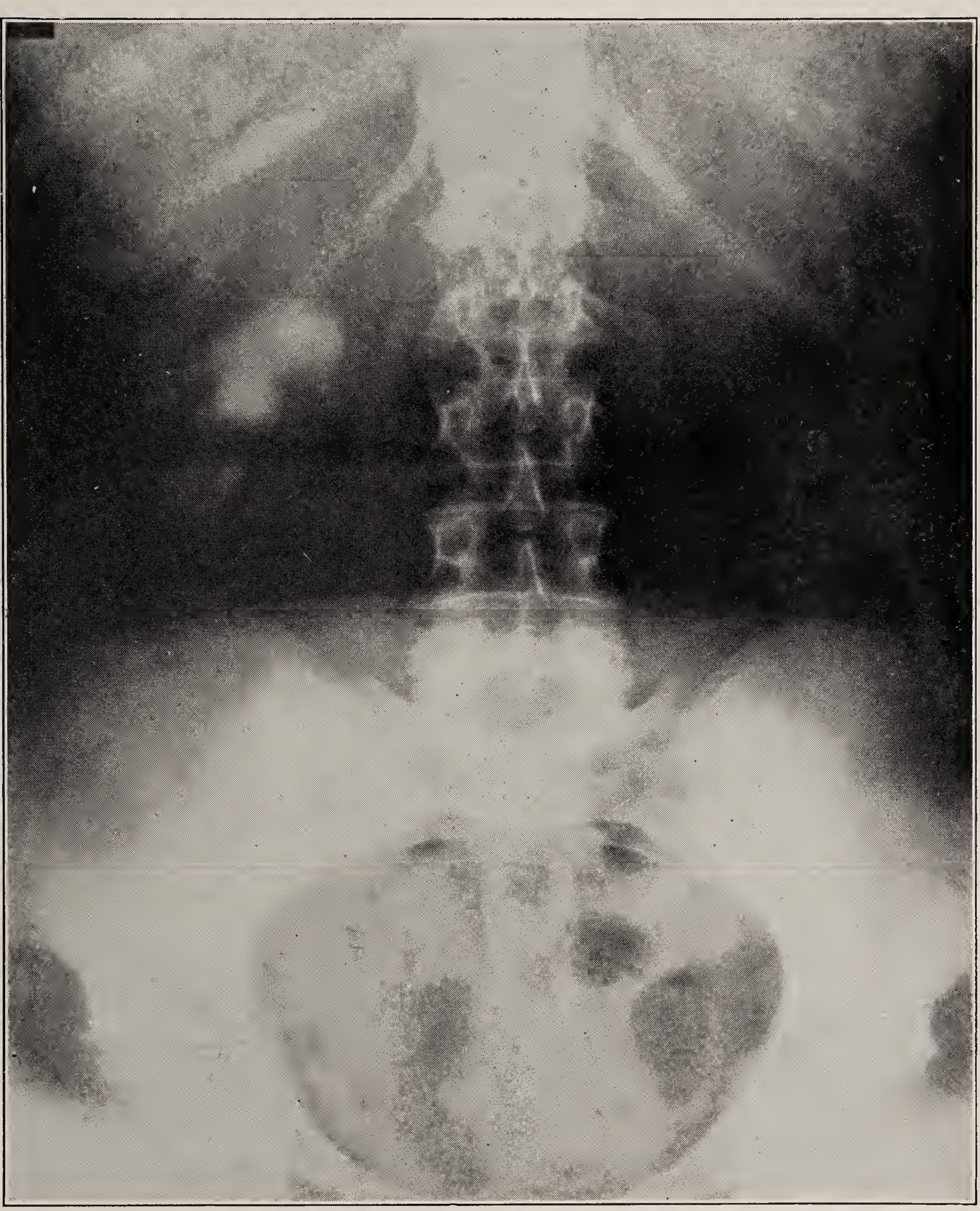

FIG. 36. Multiple dense shadows in the region of the right kidney.

for the purpose of determining the location of evasive stones. The idea is theoretically sound; however, many of the films obtained at the time of operation were so poor that they added to the surgeon's confusion rather

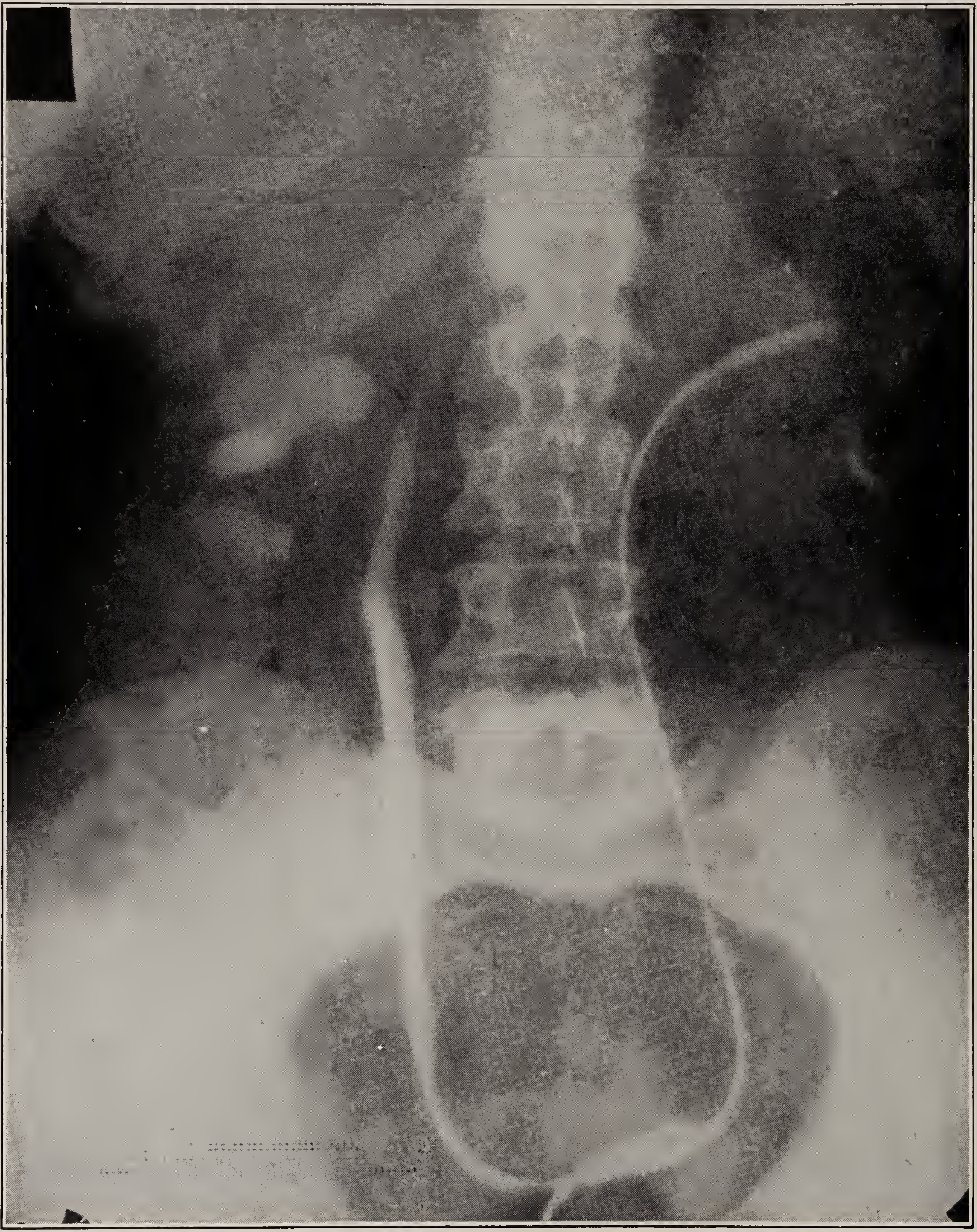

Fig. 37. Same case after injection demonstrating their presence in the pelvis proper. The sodium iodide is diluted by considerable pus in the pelvis. (Note incidental hydroureter, secondary to stricture.)

than being of assistance. Beer and Benjamin (1931) employ a special intensifying cassette for x-ray control of the exposed kidney, utilizing guide needles. Sutherland of the Mayo Clinic (1933) applies fluoroscopy for the purpose of determining the location of the calculus. The kidney is encased in an aluminum frame and three guide needles are introduced into the kidney under fluoroscopic control in different planes in such a manner that they point to and converge on the stone. He employs a special mask for visual acuity. Marion employs an ingenious x-ray apparatus which is adaptable to any operating-room.

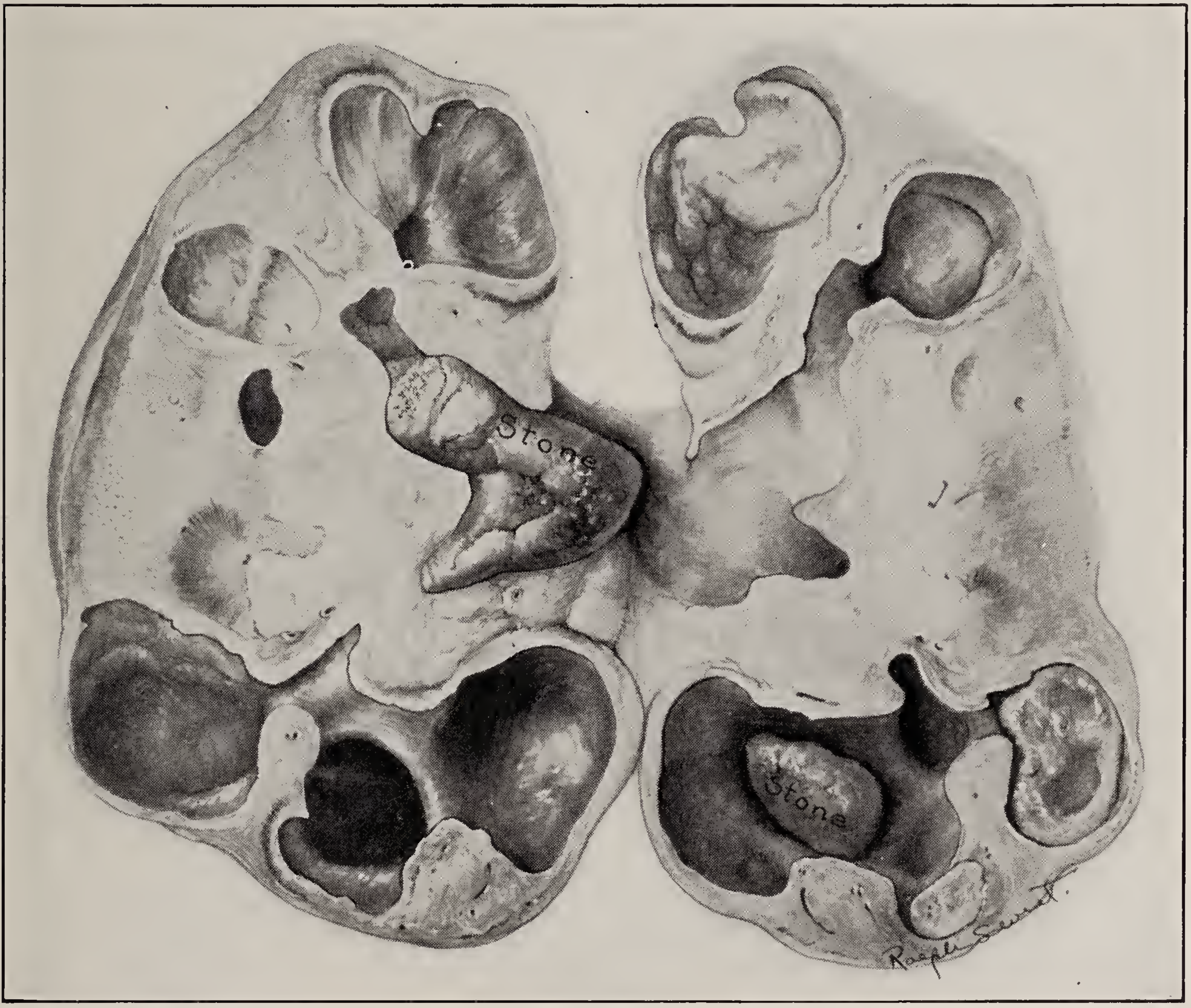

Fig. 38. Sagittal section of kidney of same case removed at operation, showing advanced hydronephrosis, stag-horn calculus, and smaller calculus of the lower pole.

TUMORS OF THE KIDNEY AND URETER

Tumors of the kidney are often suspected by the cardinal symptoms of pain, tumefaction and hematuria, and by an enlarged or abnormal

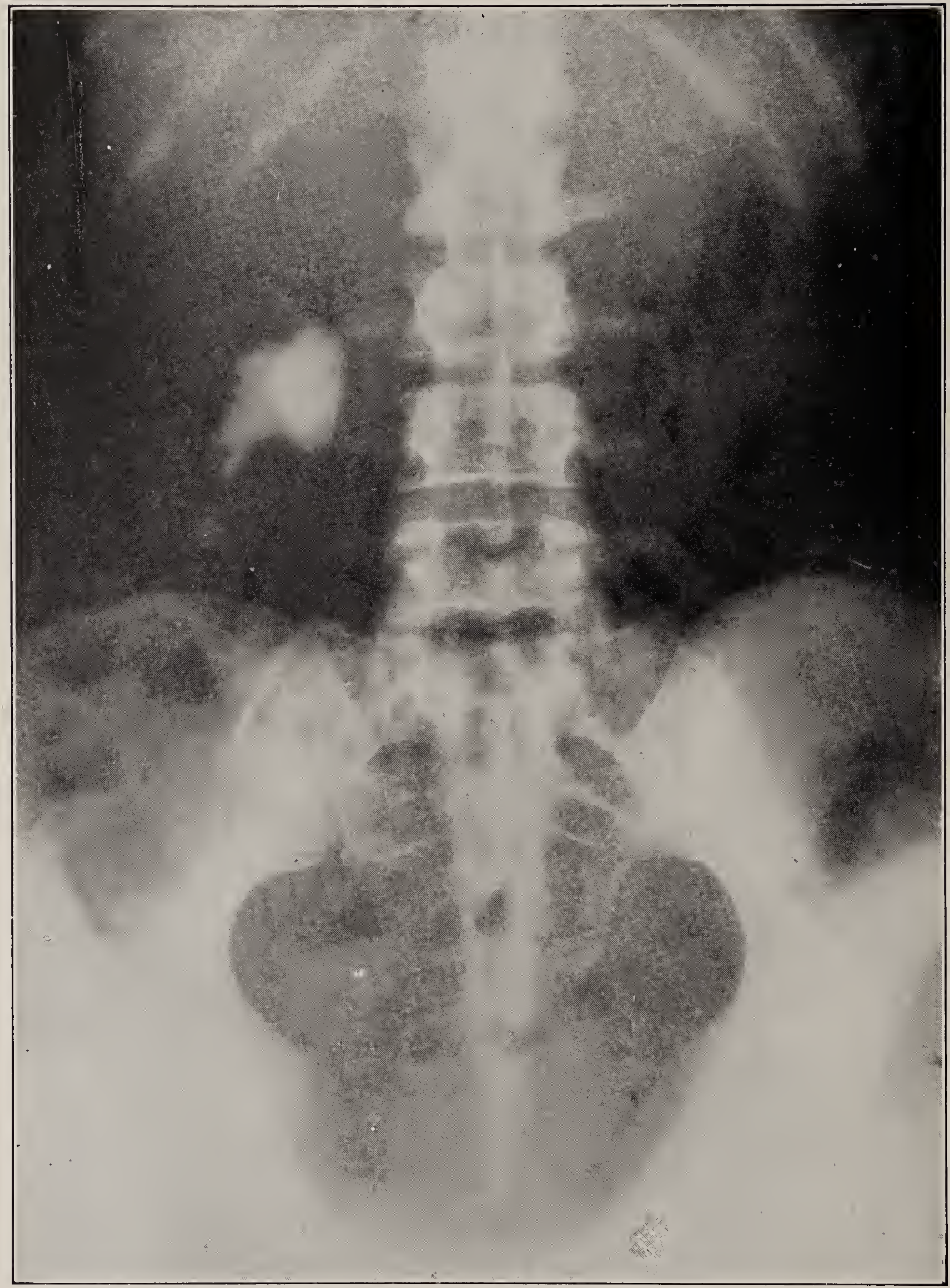

FIG. 39. Plain film showing large stag-horn calculus and separate smaller calculus in the region of the lower pole of a ptosed kidney.

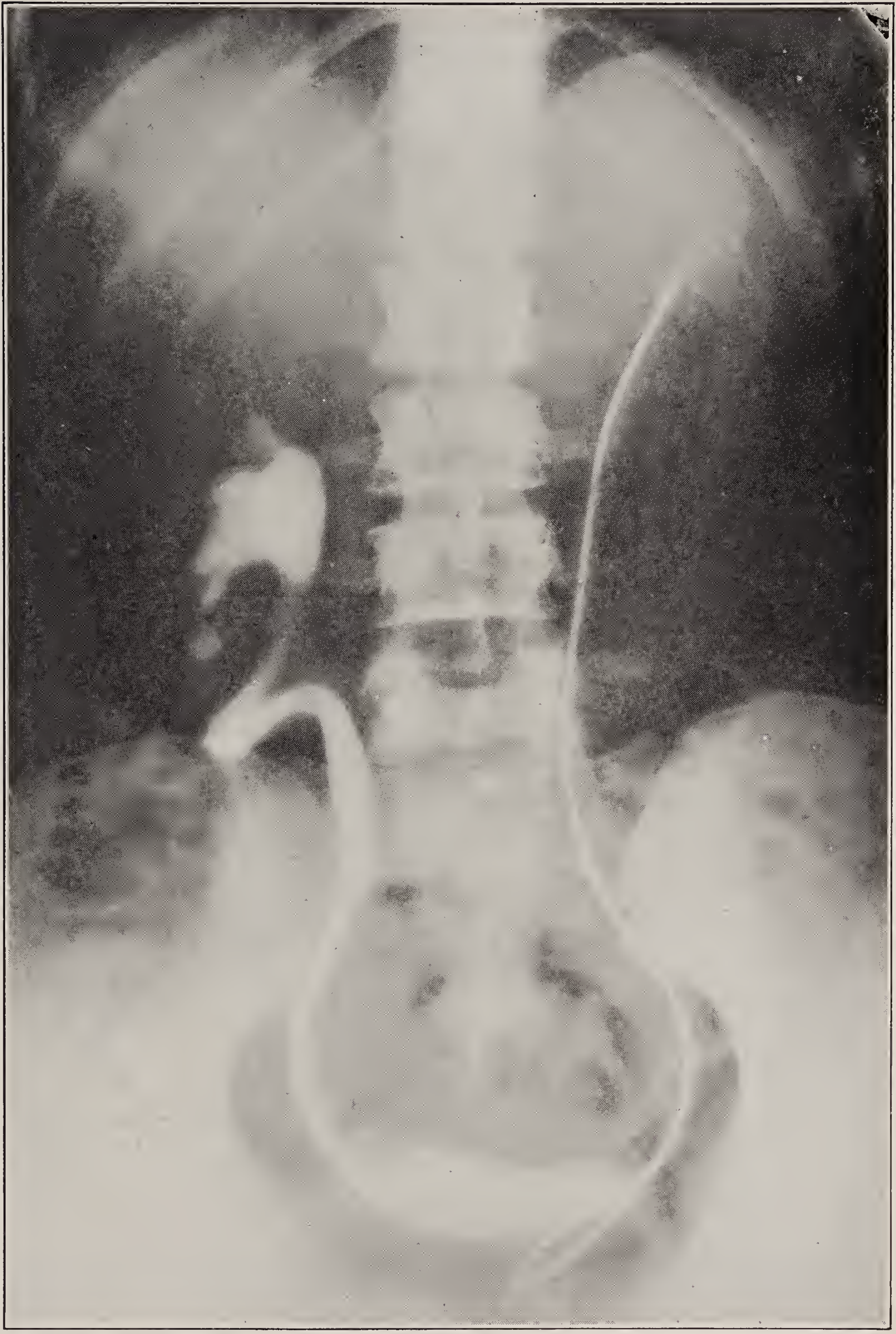

FIG. 40. Pyelo-ureterogram showing dilated and tortuous ureter. Note relative higher position of the left kidney as demonstrated by the opaque catheter.

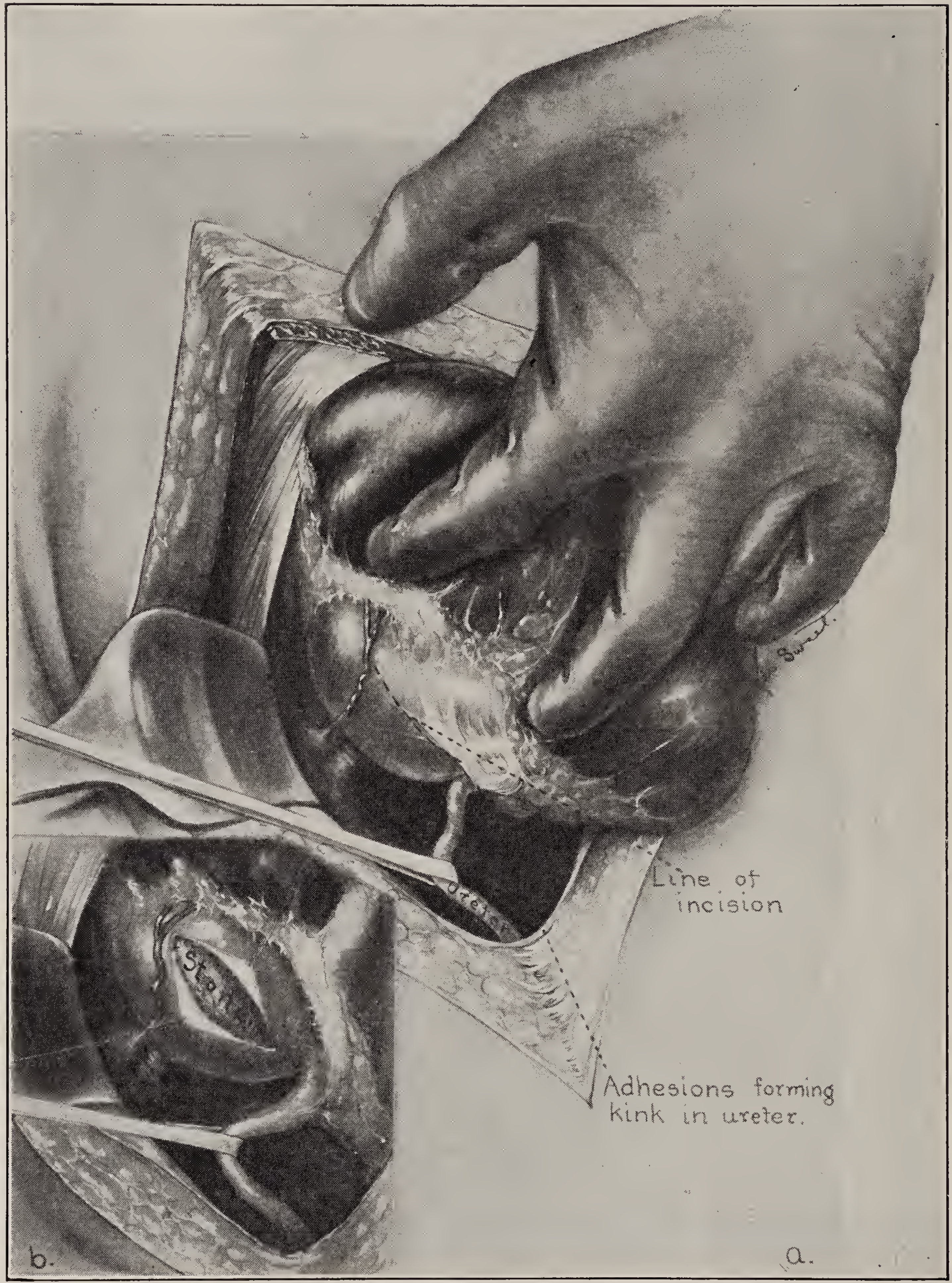

Fig. 41. Drawing made at operation. Note the adhesions forming kink in the ureter. The stag-horn calculus and the smaller calculus were removed through a pyelotomy incision.

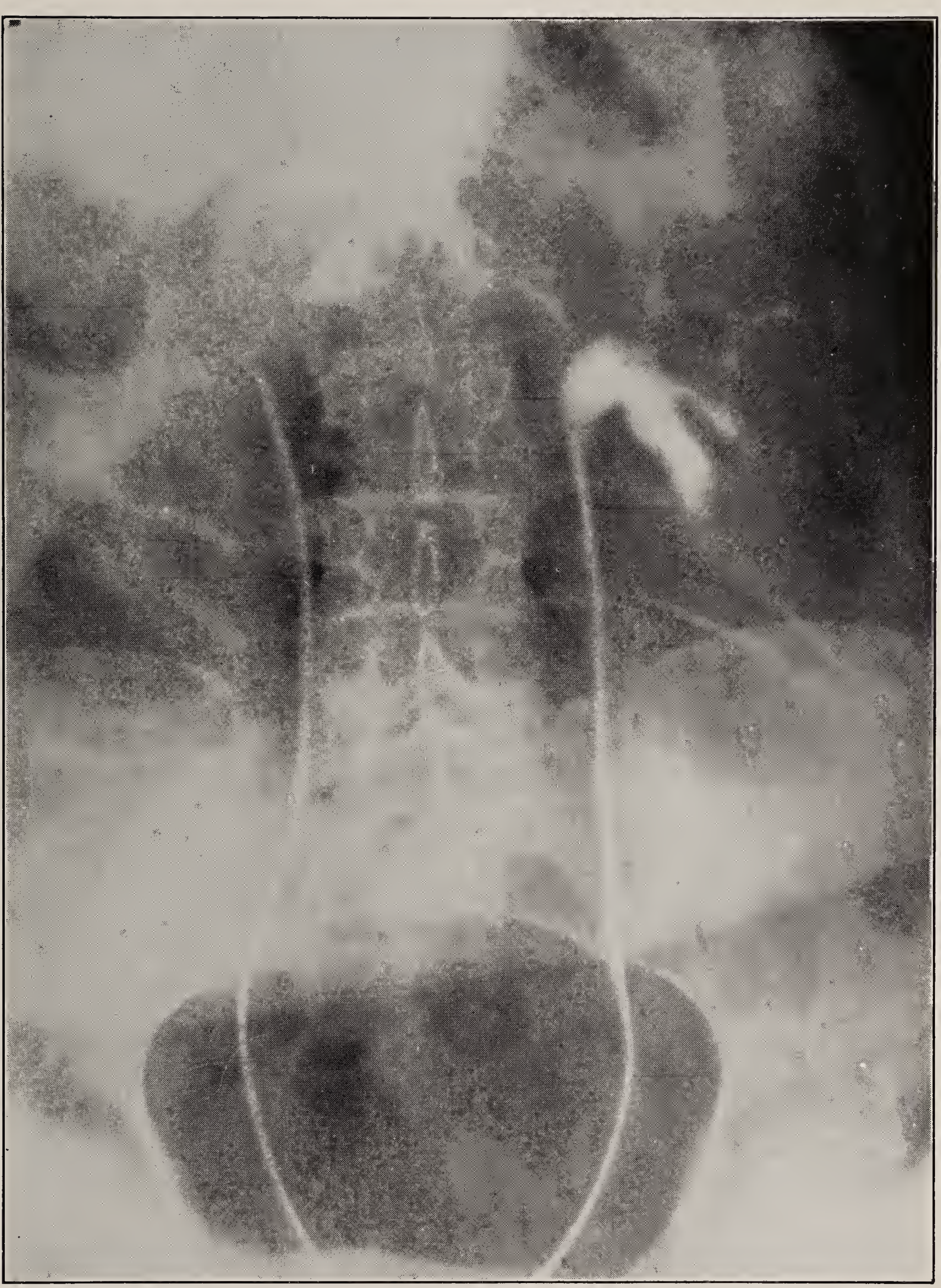

Fig. 42. Horizontal position. Filling defect in upper pole of left kidney probably due to tumor.

outline of the kidney shadow noted in taking the plain film. Although the pathological processes underlying tumefaction of the kidney follow no general rule, the growth of the tumor itself causes certain definite pressure defects of the pelvis which are more or less diagnostic of the kidney neoplasm. In patients presenting emaciation, generalized weakness and lowered resistance due to advanced tumor formation, pyelography should not be employed. One must be thoroughly familiar with variations in the normal pelvis and not confuse the pelvis possessing an elongated upper major calyx or the pseudo-spider type with early changes due to kidney tumor. Pyelography also affords us an opportunity of differentiating kidney neoplasms from enlarged intra-abdominal organs and other tumors. The growth of the tumor can cause an elongation of one or

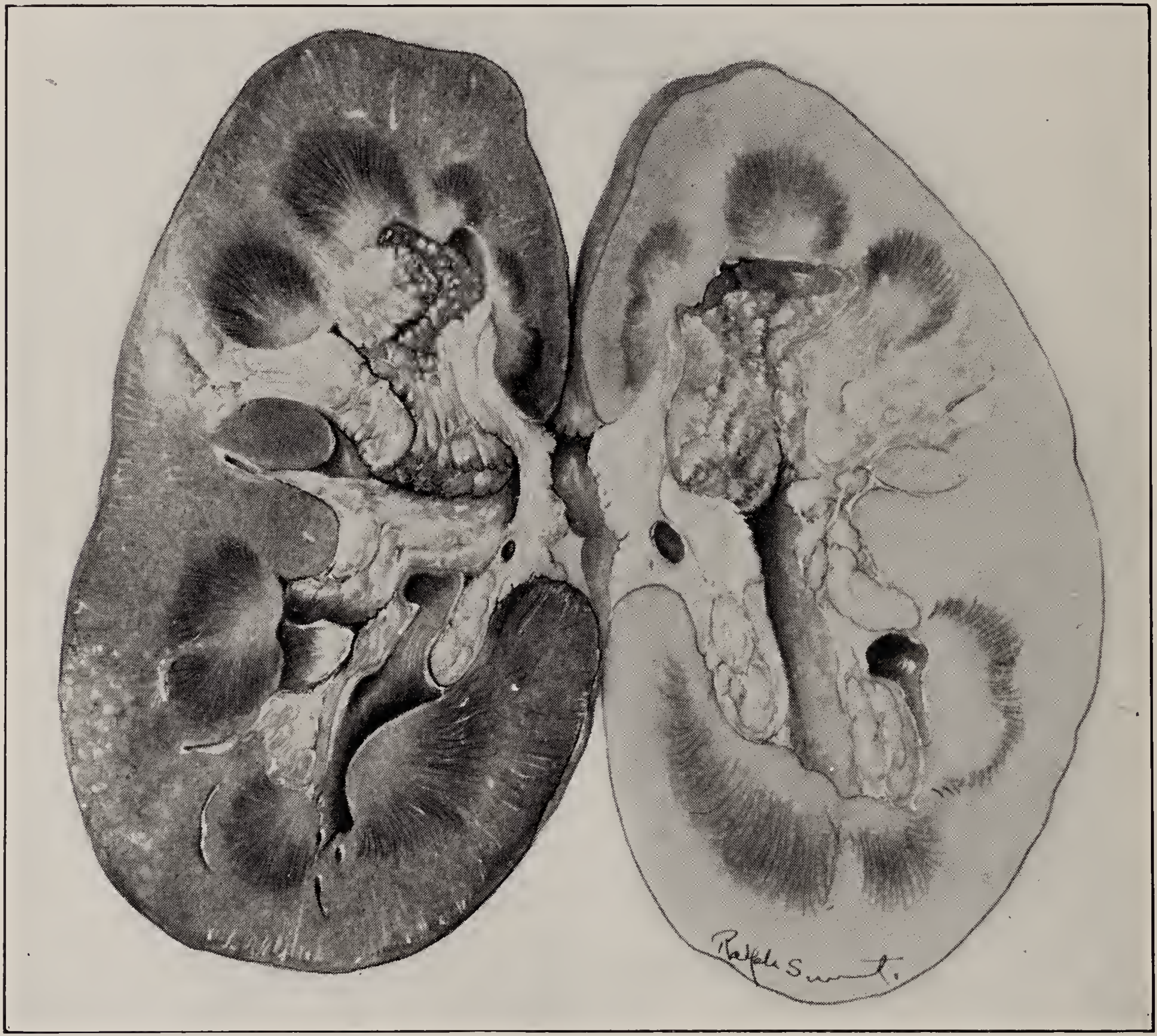

FIG. 43. Same case showing sagittal section of kidney removed at operation containing an adeno-carcinoma of the upper pelvis.

more calyces and by actual compression cause retraction of the calyces or pelvis itself. Conversely the tumor by pressure on the lower portion of the ureter or pelvis can cause back pressure resulting in dilatation of the pelvis and calyces forming a true hydronephrosis. In its growth the

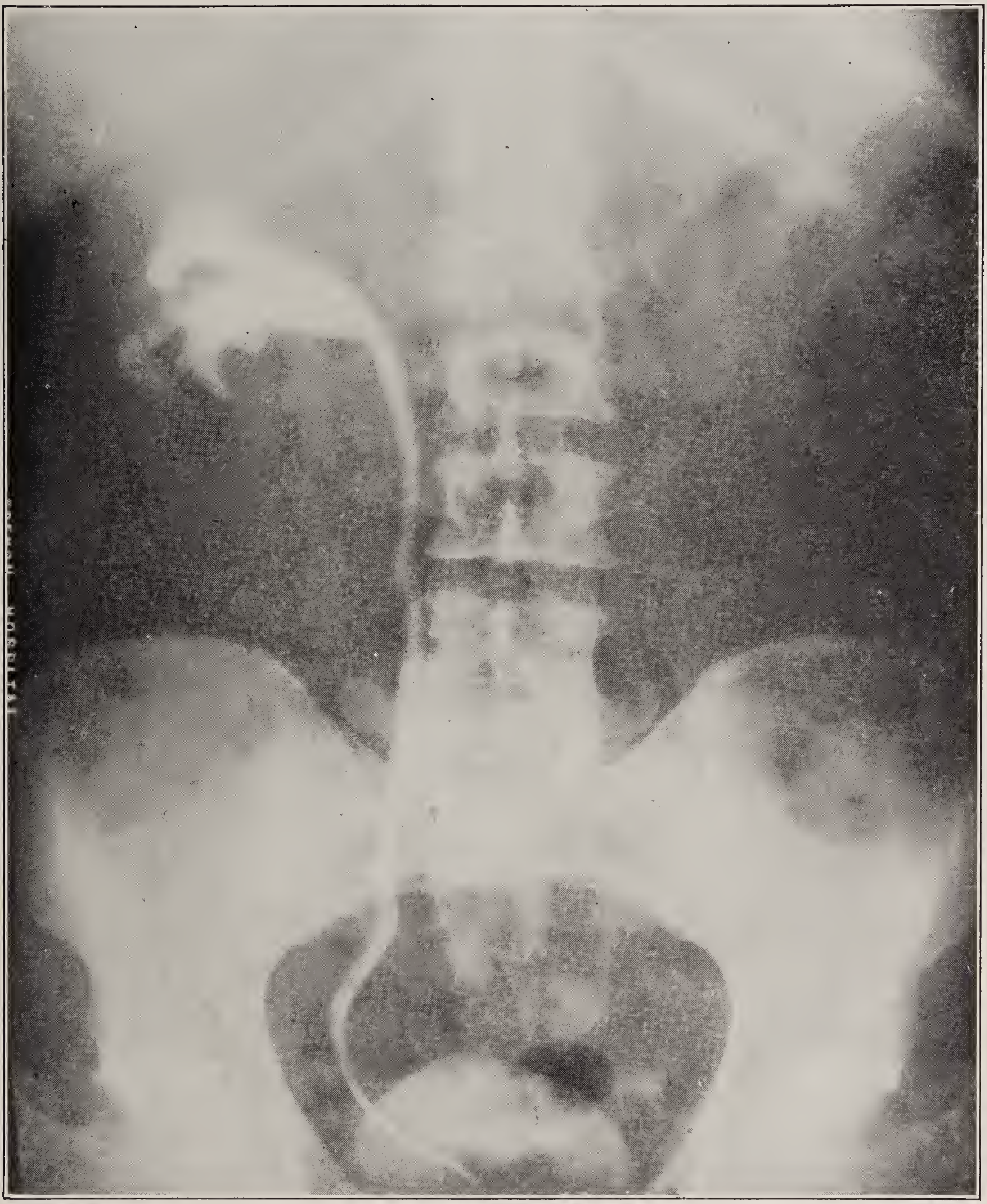

FIG. 44. Right pyelogram showing distortion of uretero-calicine angle with atypical appearance of lower calyces; possible tumor of lower pole.

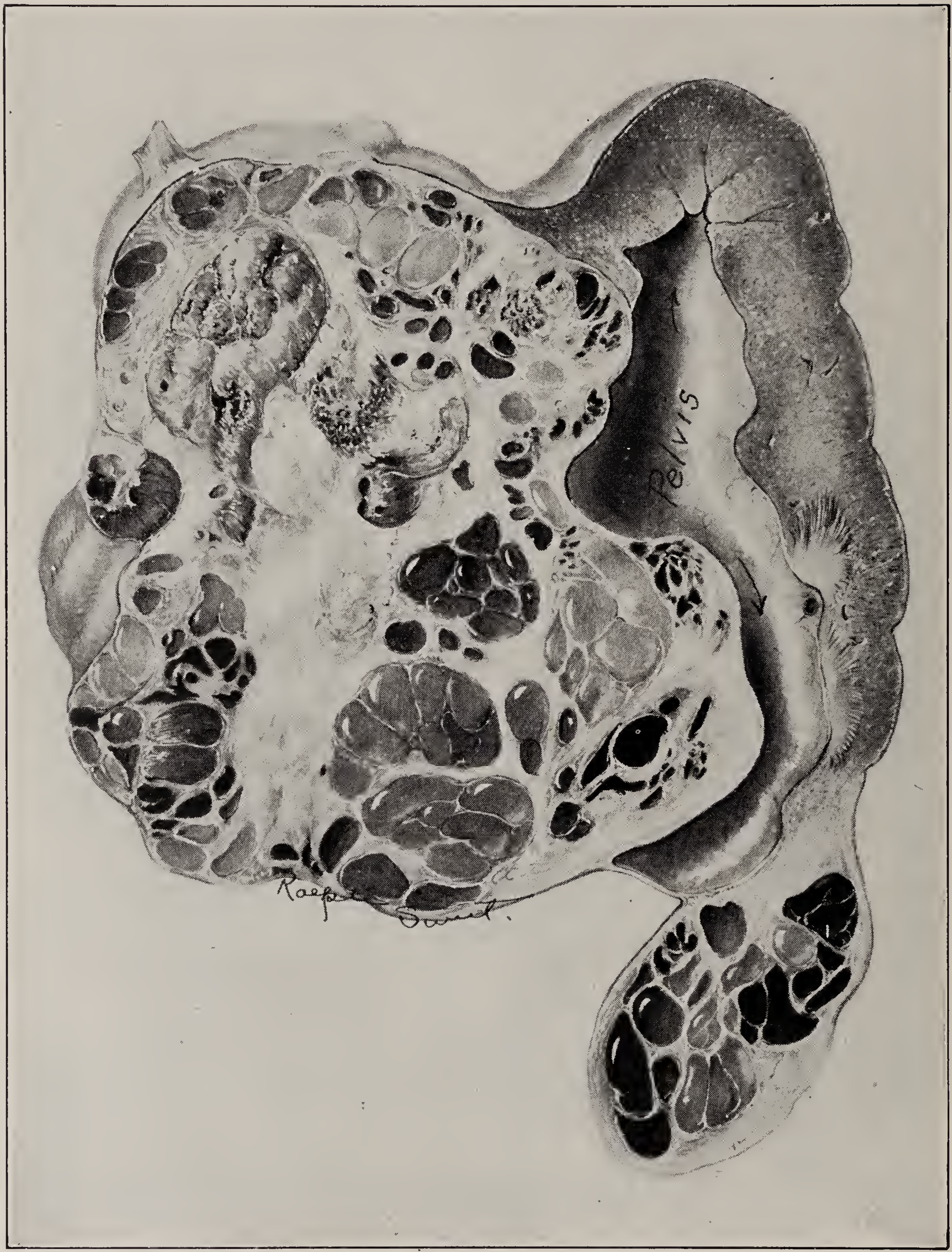

FIG. 45. Extensive adeno-carcinoma of lower pole. This was the cause of the pelvic distortion seen in Fig. 44.

tumor may compress the pelvis causing a narrowing of its outline, resulting in the so-called spider- or dragon-shaped distortion. It can displace the ureter causing more or less kinking of its upper portion.

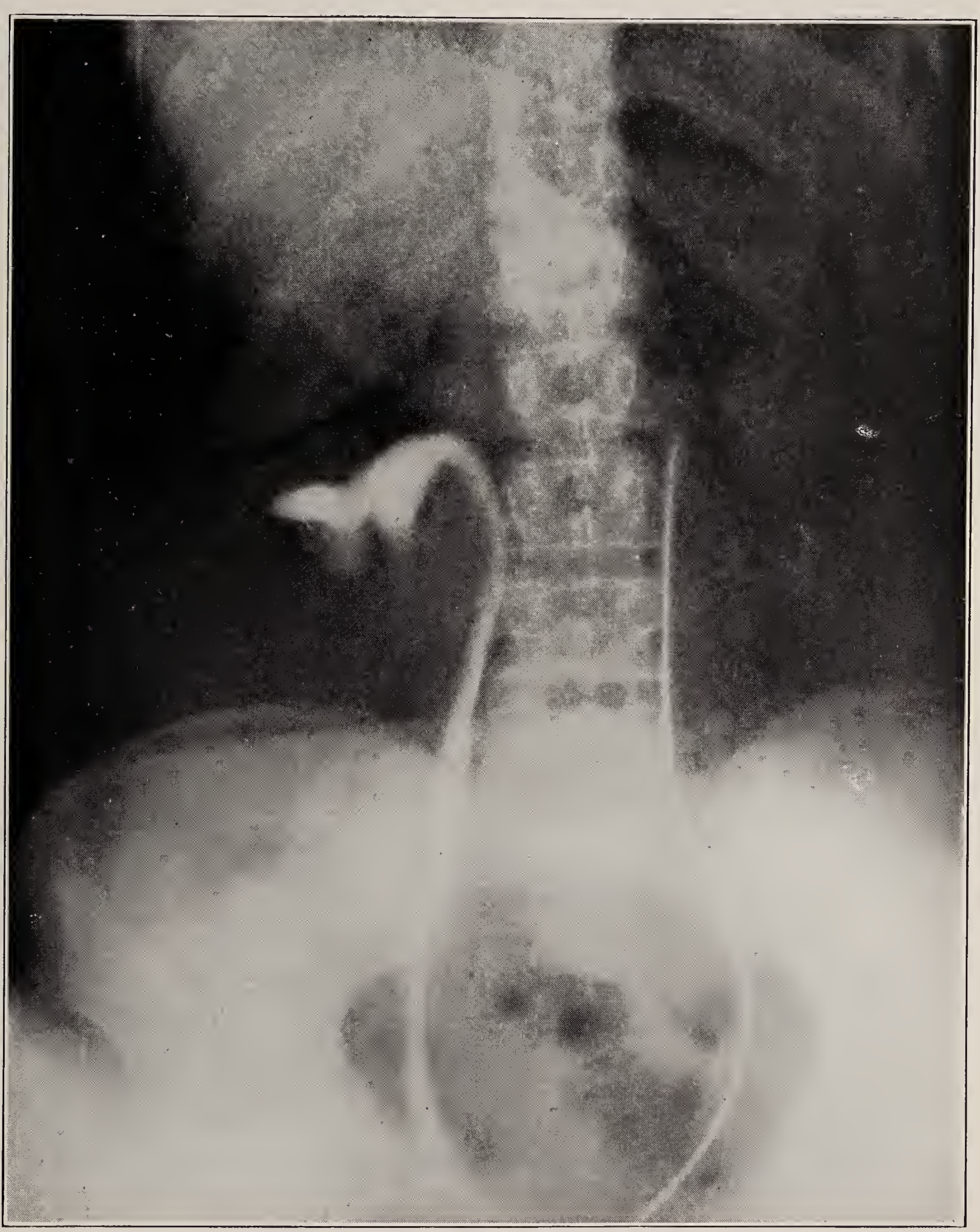

Fig. 46. Right pyelogram showing pressure distortion of pelvic outline, absence of minor calyces and abnormal enlargement of lower pole, neoplasm or cyst. (Solitary cyst of lower pole found at operation.)

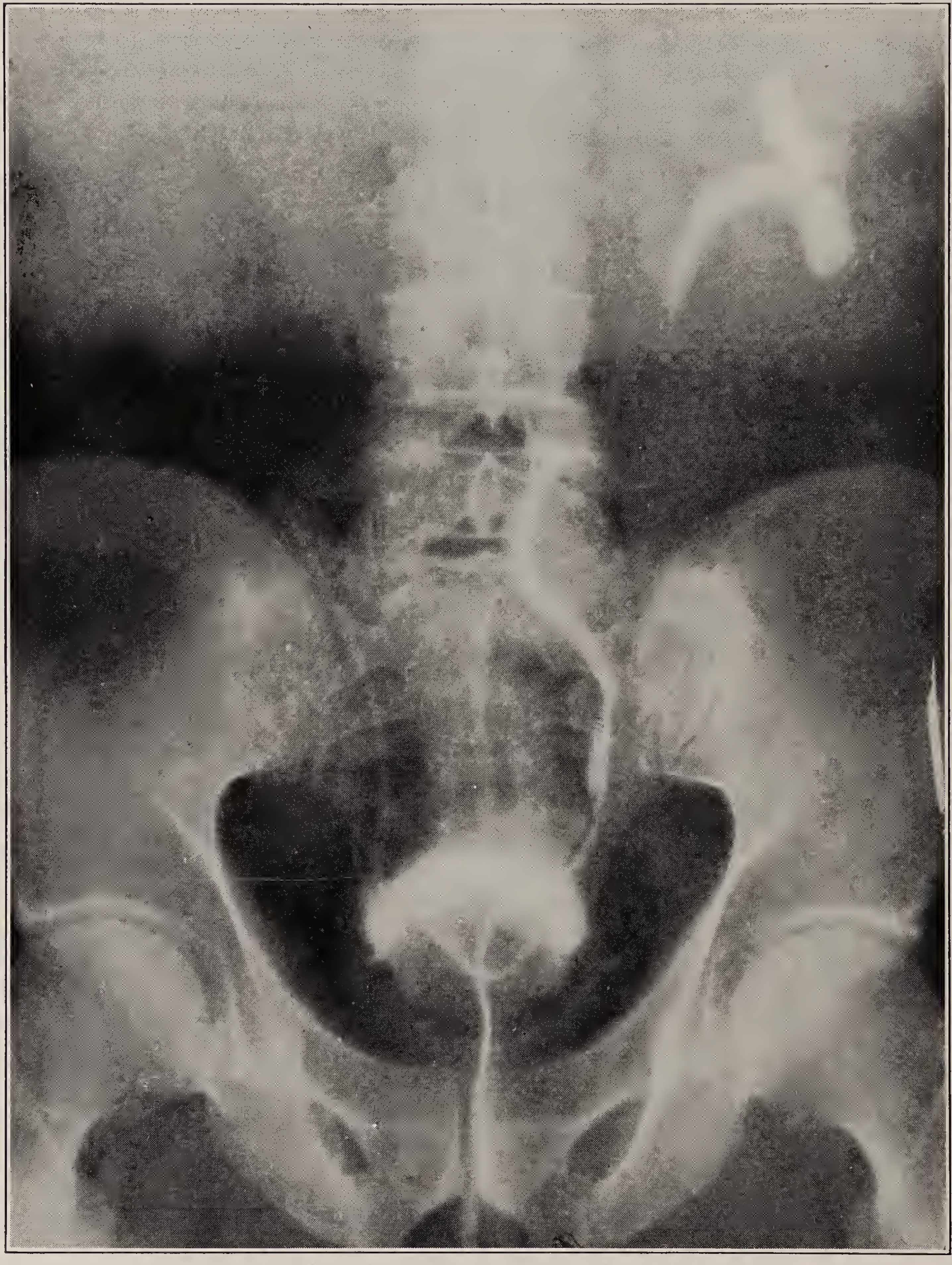

FIG. 47. Pyelo-ureterogram showing moderate hydronephrosis with tortuosity of the ureter. (Secondary to infra-vesical back pressure caused by hypertrophy of the prostate.) The vesical encroachment of the prostate is clearly demonstrated.

In advanced cases the tumor may almost entirely obliterate the pelvis. Secondary necrosis simulates the impression of abscess formation.

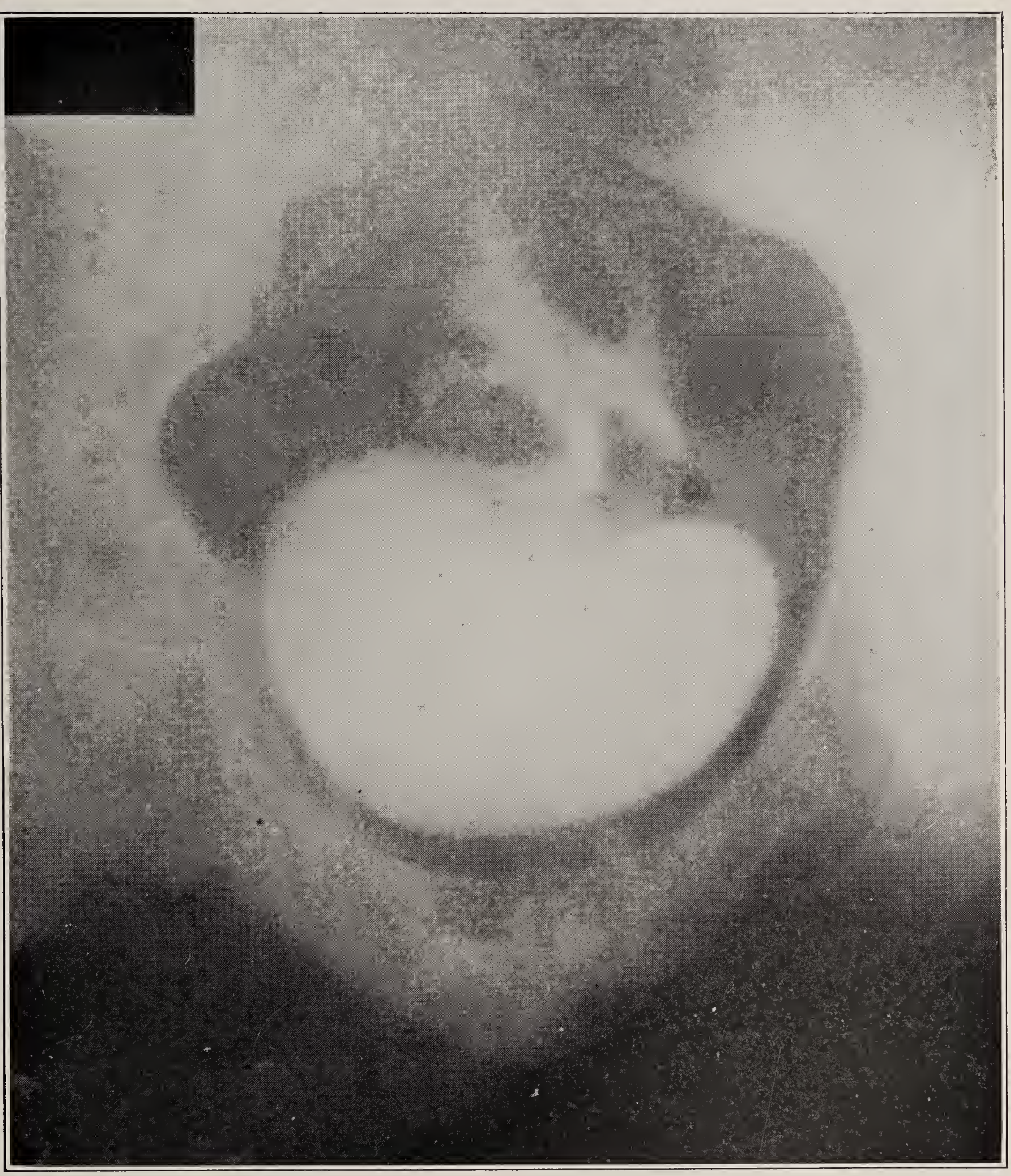
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FIG. 48. Cystogram showing vesico-rectal fistulae.

Ureteral tumors are of rare occurrence. In certain instances they may be suspected by the resistance encountered in the passage of the ureteral catheter and by a pressure defect noted in the continuity of the

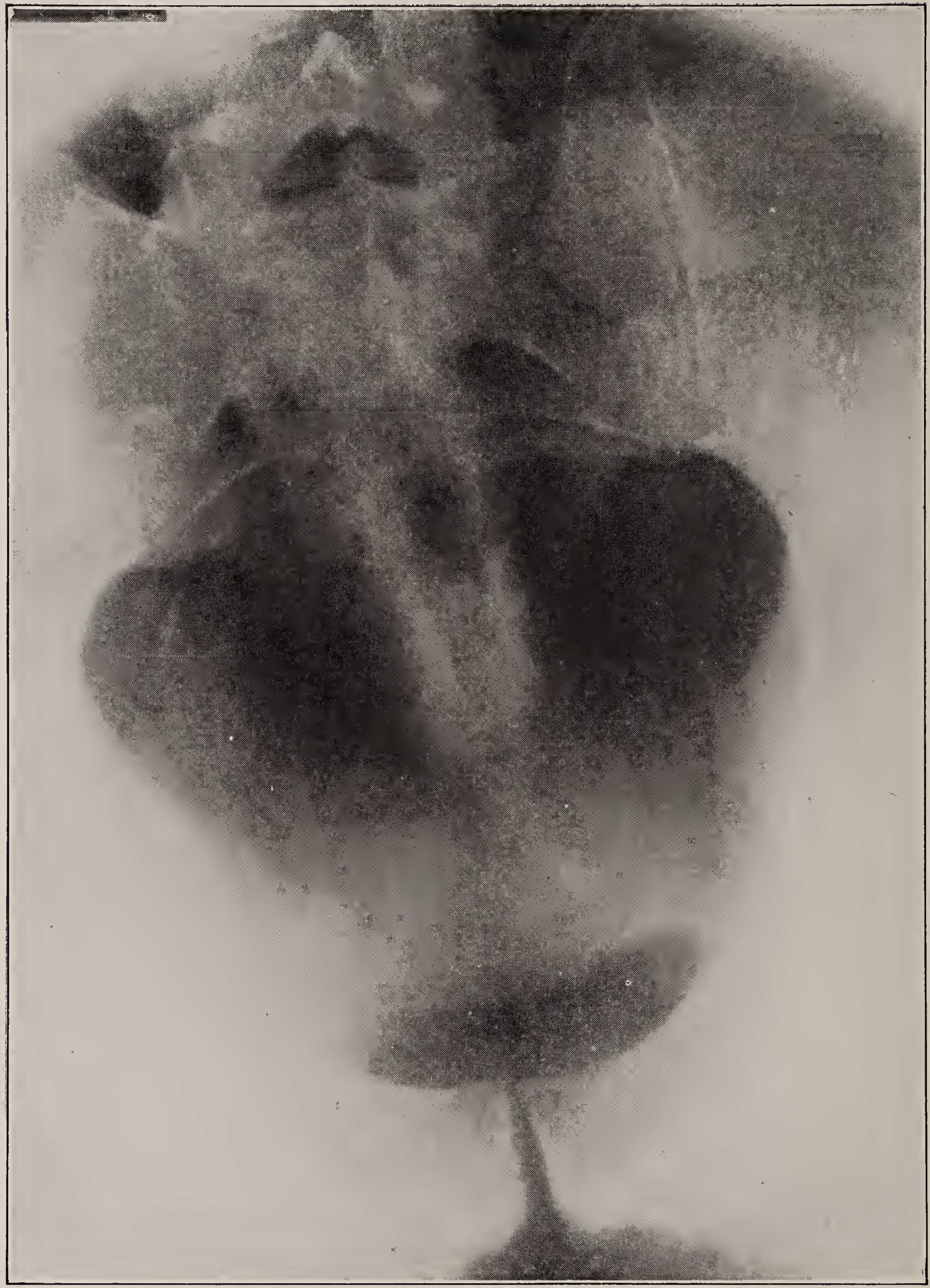

FIG. 49. Same case uninjected showing vesical calculus. Note: In spite of the presence of the calculus it seems the fistula was secondary to an old prostatic abscess.

ureter, determined in making a ureterogram. If the tumor has increased in size to such an extent as to cause obstruction, the ureter and pelvis will be dilated above this point. In early tumors ureteropyelography gives little if any assistance because in these cases the tumor will not have sufficiently increased in size to cause any pressure defect.

Primary carcinoma of the ureter. A case of this rare condition was recently observed by us in which ureteropyelography was of great aid in establishing the diagnosis. One is able to make a satisfactory film when the catheter can be passed by the obstructing tumor. In these a filling defect in the lumen of the ureter is encountered, above which one sees hydroureter and hydronephrosis due to dilatation of the ureter and pelvis resulting from back pressure. In some cases the ureter has a moth-eaten appearance very much like that produced by tuberculosis. In those cases in which one is unable to pass a catheter by the obstructing tumor intravenous urography is of great assistance and by

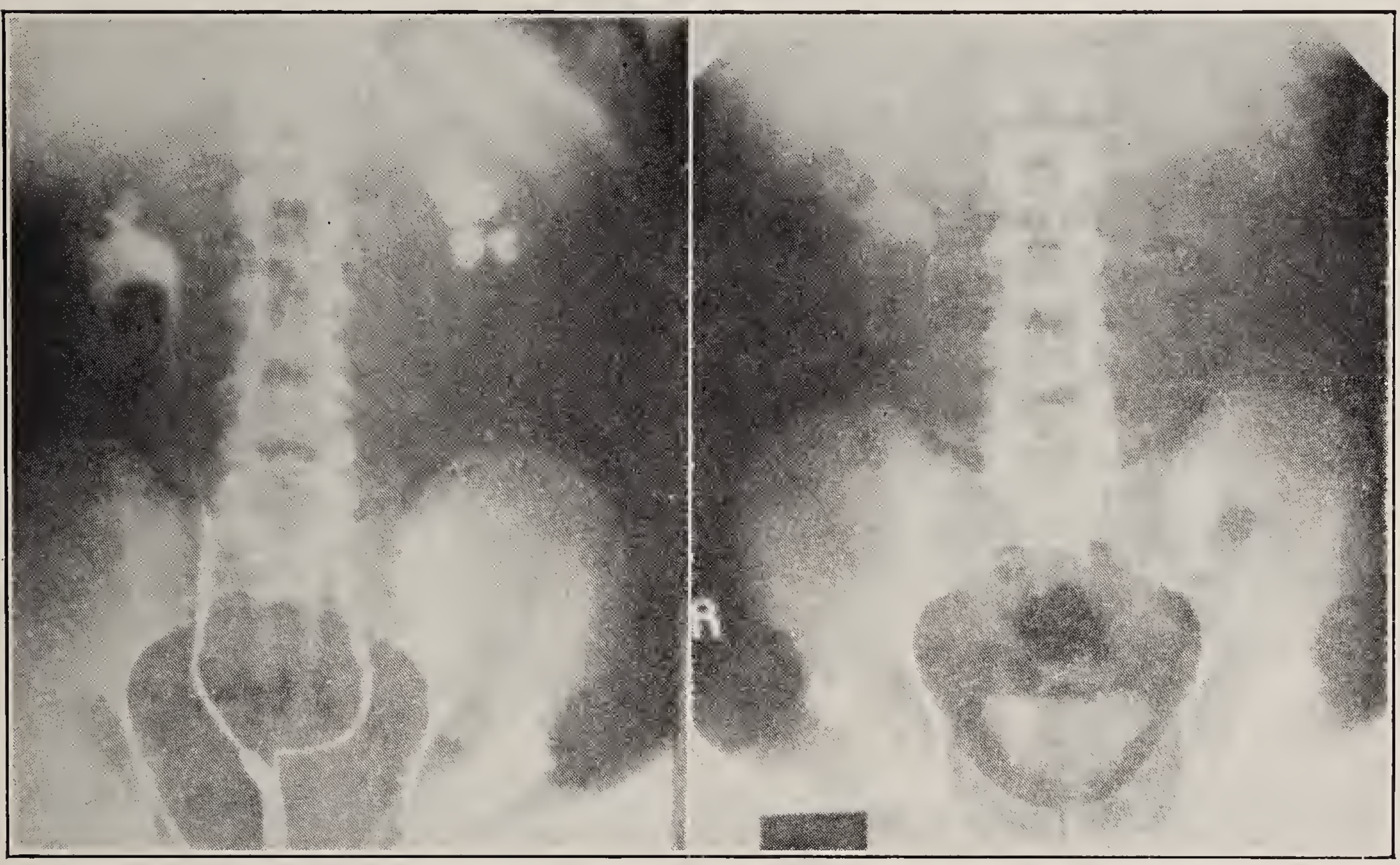

Fig. 50a. Case of primary carcinoma of ureter: Retrograde bilateral pyelogram in patient aged 44 suffering from repeated attacks of left-sided renal colic. The opaque solution has filled the lower portion of the left ureter to the portion involved by the cancer of the ureter. A small amount of the opaque substance has passed by this obstruction filling the upper and major calyces of the kidney, which are considerably dilated.

Fig. 50b. Intravenous pyelogram showing normal kidney pelvis on right side. Note that none of the opaque solution was secreted by the left kidney.

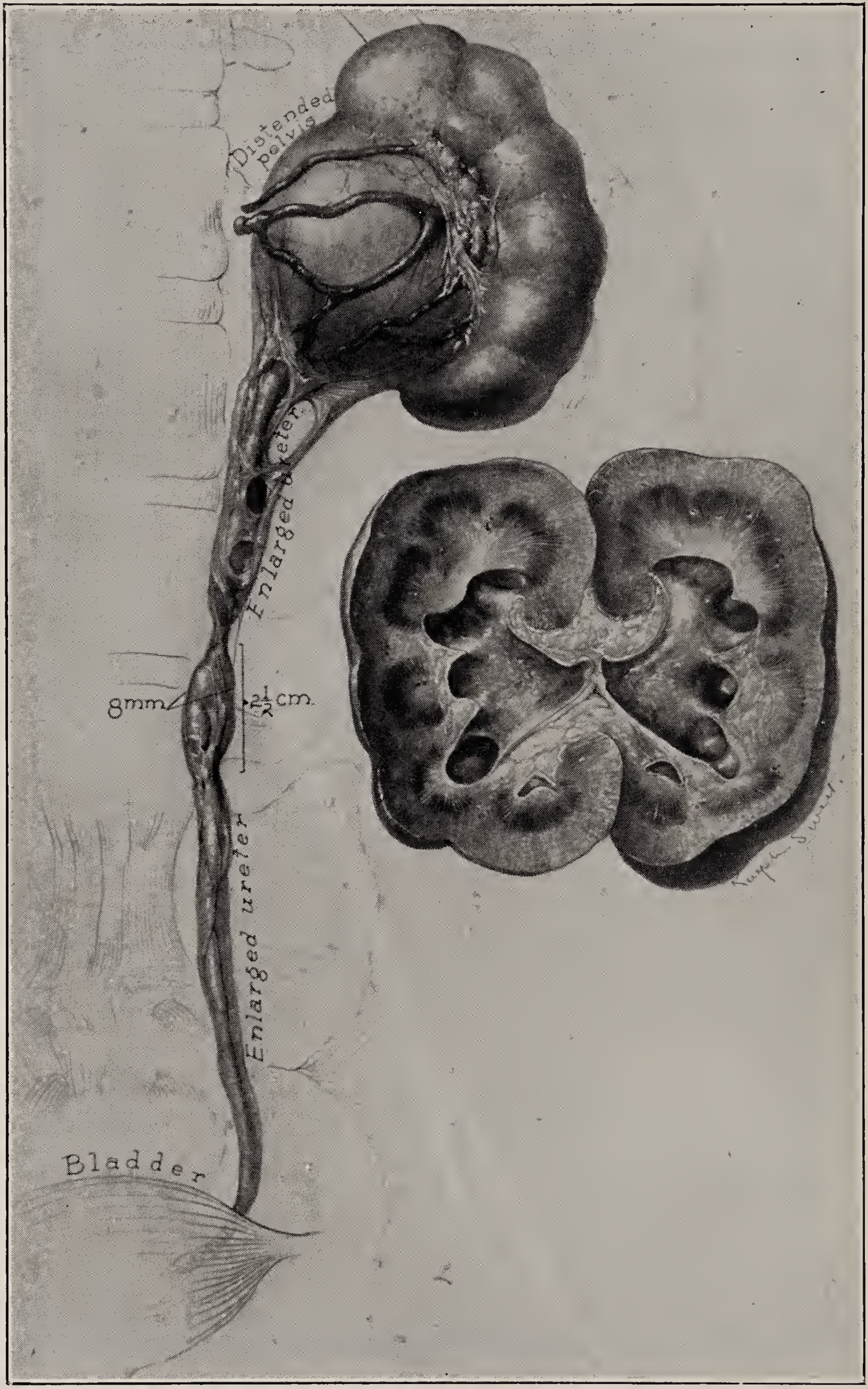

FIG. 50C. Illustration showing carcinoma of ureter and accompanying hydronephrotic kidney removed at operation.

its employment one can observe the diagnostic signs enumerated above. As the tumor produces obstruction to the outflow of urine, the film ob-

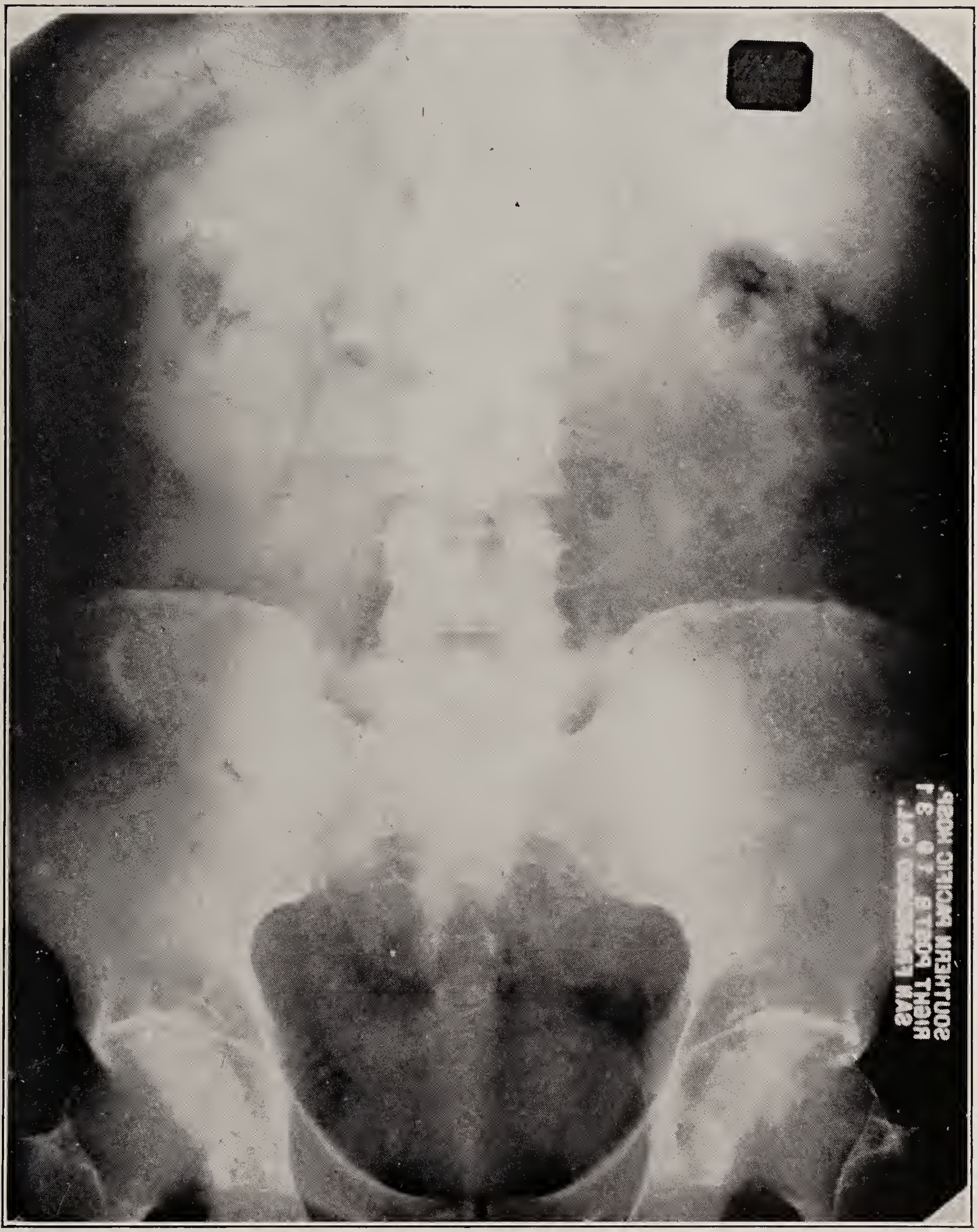

Fig. 51a. Roentgenogram showing aneurism of the renal artery which consists of a wreath-shaped shadow in upper pole of the left kidney, presenting a relatively denser periphery. Note 7 calculi laterad and cephalad to this shadow.

tained by the ureteropyelogram (except in advanced cases in which the dye is no longer excreted by the kidney) is a very good one and will demonstrate the characteristic pressure defect of the ureter.

POLYCYSTIC KIDNEY. SOLITARY RENAL CYST

Polycystic kidney should be suspected in those patients presenting enlarged palpable, bilateral, nodular kidneys. The characteristic spider-like type of deformity of the pelvis is encountered in which the injected opaque solution is seen to enter regular rounded cavities consisting of the adjacent cysts that may communicate with it. Solitary cysts are usually unilateral, occur rarely and cause considerable pressure on the pelvis that varies in direct proportion to their size. The entire pelvis may be very much narrowed and the proximal major calyces elongated. In taking the plain film, the kidney itself can be actually seen to be enlarged in the region of the cyst.

ANEURISM OF THE RENAL ARTERY

Having recently encountered this rare surgical condition of the kidney, I take this occasion to call attention to roentgenographic appearance which aids materially in its diagnosis. When the aneurism contains calcification of its wall it becomes opaque to the x-ray and can be readily detected. It may be easily confused with renal calculus, calcified cyst, or abscess of the kidney, or with gall-stone when it occurs on the right side. Calcified aneurism presents a characteristic opaque ring-like shadow in the kidney region, with a relative denser peripheral zone. This wreath-like shadow should always make one suspicious of renal aneurism and its differentiation from calcified cyst, calcified lymph gland, calcified abscess of the kidney, and some types of renal calculus requires careful consideration of all other possible data obtained by cystoscopic study, including examination of the urine, functional renal studies, pyelography, et cetera. In doubtful cases, injection of the aorta with 15 to 20 cc. of 100 per cent. sodium iodide solution, for the purpose of obtaining an arteriograph of the kidney, as recently recommended by De Santos of Lisbon, is of great aid in localizing aneurism of the renal artery. This procedure is highly technical and not without danger.

PNEUMONEPHROSIS

This exceedingly rare surgical disorder of the kidney recently came under our observation. It gives a characteristic roentgenographic appearance. This consists of a round opaque area situated in, and usually associated with, enlargement of the kidney, which has the appearance of a collection of gas. If this condition involves the pelvis, it presents

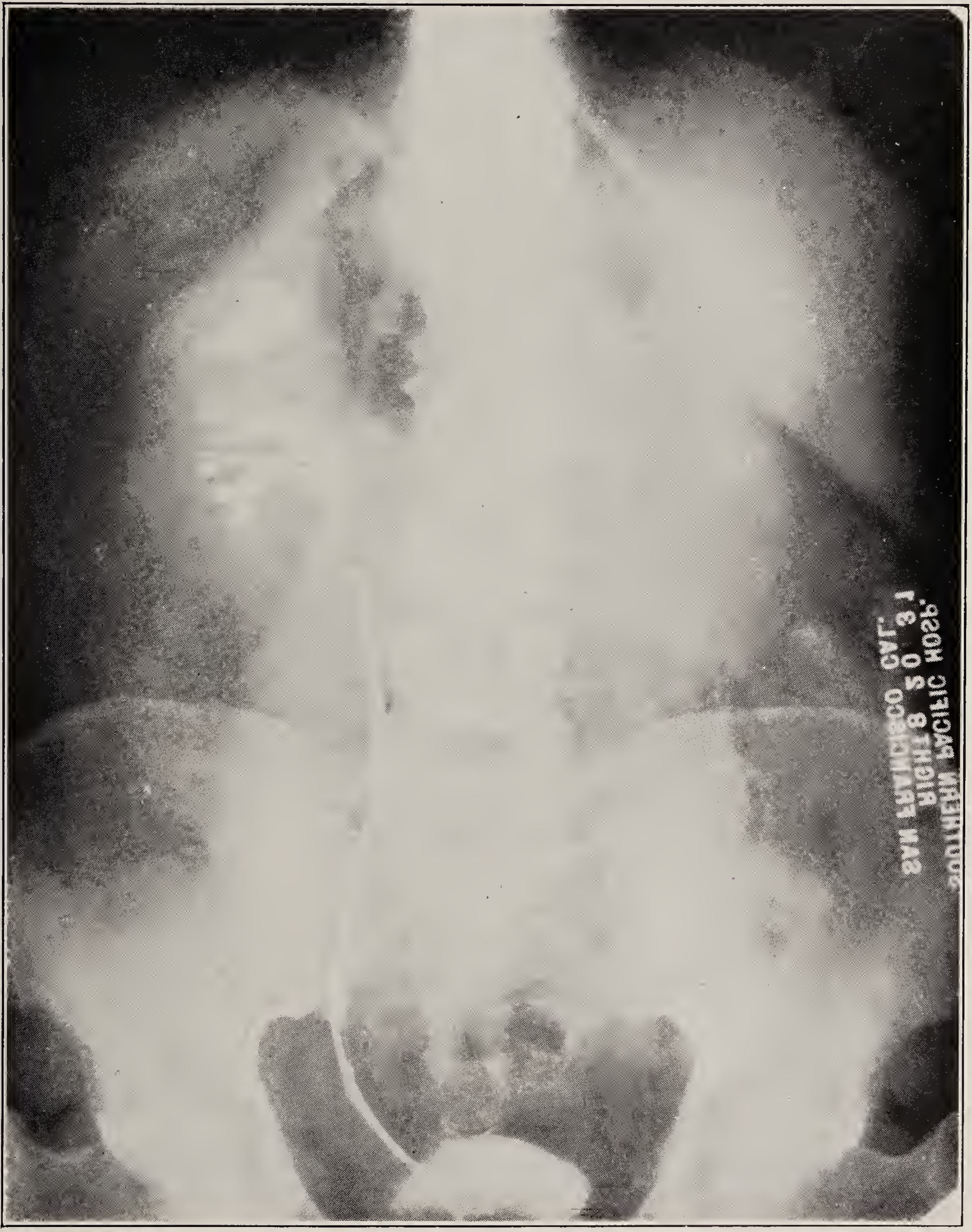

Fig. 51b. Ureteropyelogram of same kidney showing this shadow to be mesiad to the dilated upper major calyx containing the calculi.

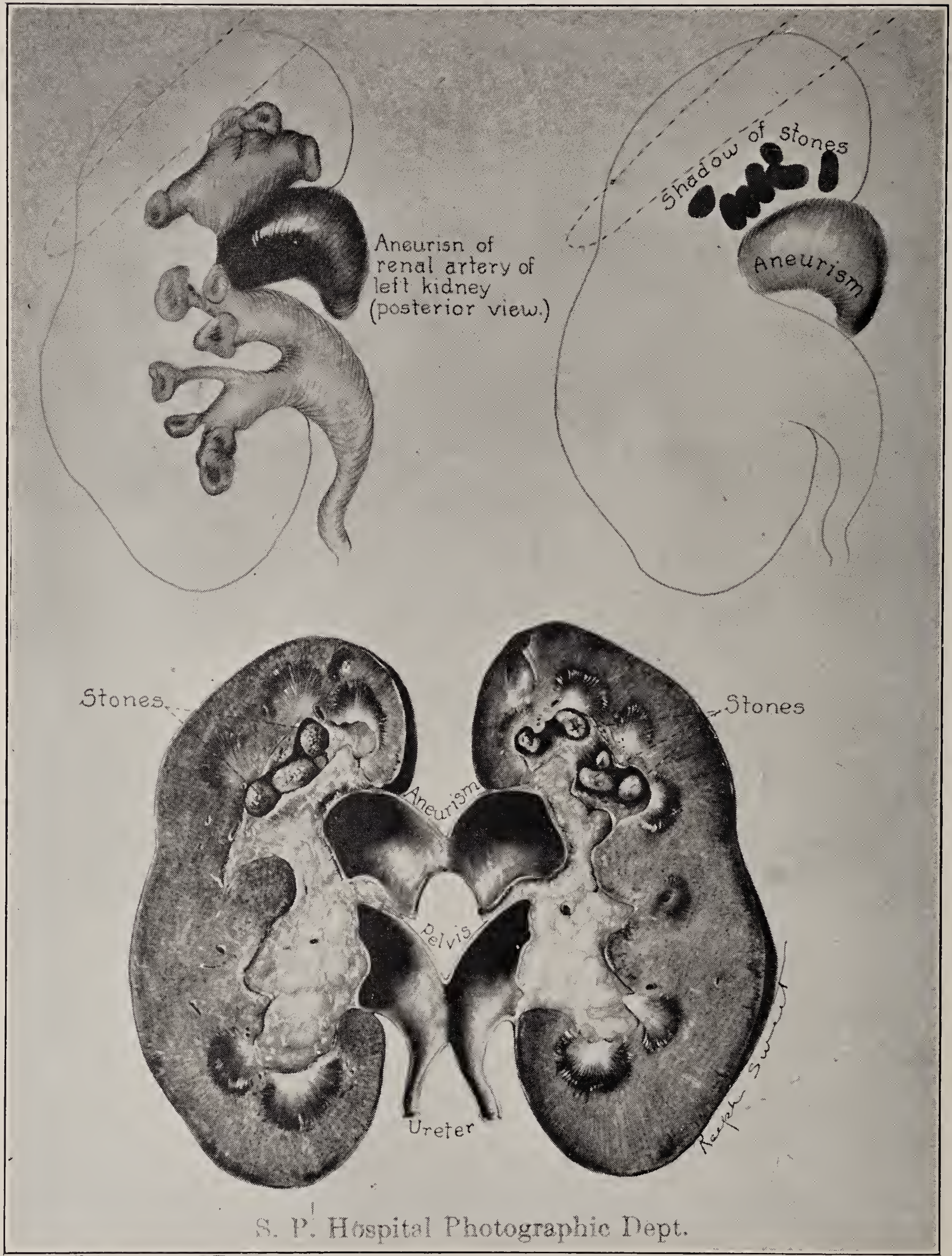

Fig. 51c. Illustration of kidney containing aneurism removed by operation.

the characteristic appearance of complete obstructed hydronephrosis excepting that air is also present. If it occurs in an encapsulated cyst

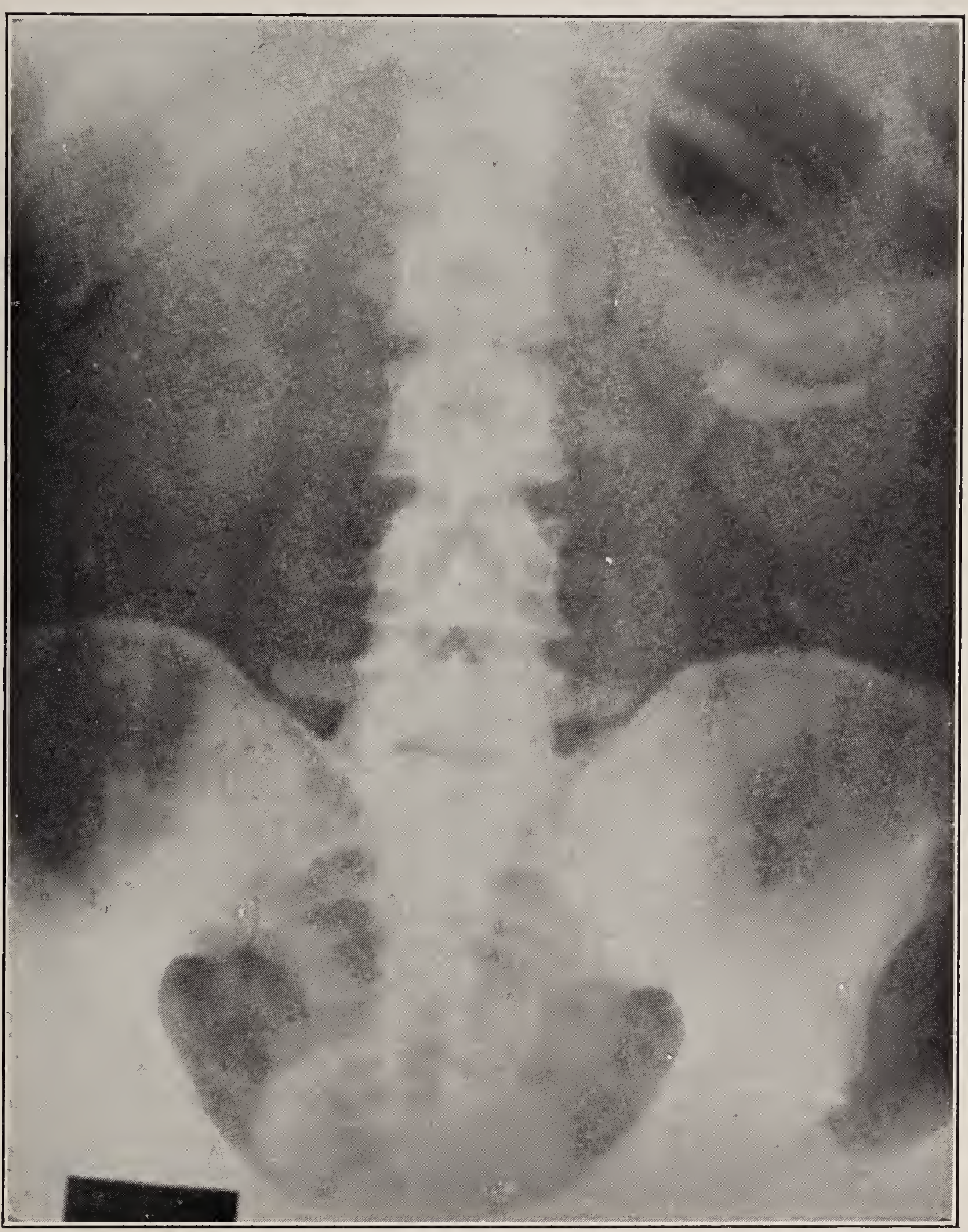

Fig. 52a. Intravenous pyelogram demonstrating pneumonephrosis. Note the huge enlargement of left kidney and bizarre pressure defect of the pelvis which is flattened out by a large, round, tumor mass the size of a toy balloon situated in the upper portion of the kidney, the upper two-thirds of which presented a shadow characteristic of air and the lower third that of thick fluid. Film also shows duplication of pelvis and ureter of right kidney.

or abscess located in the parenchyma it might cause various pressure defects of the pelvis, the latter usually being flattened out by the adjacent tumor mass.

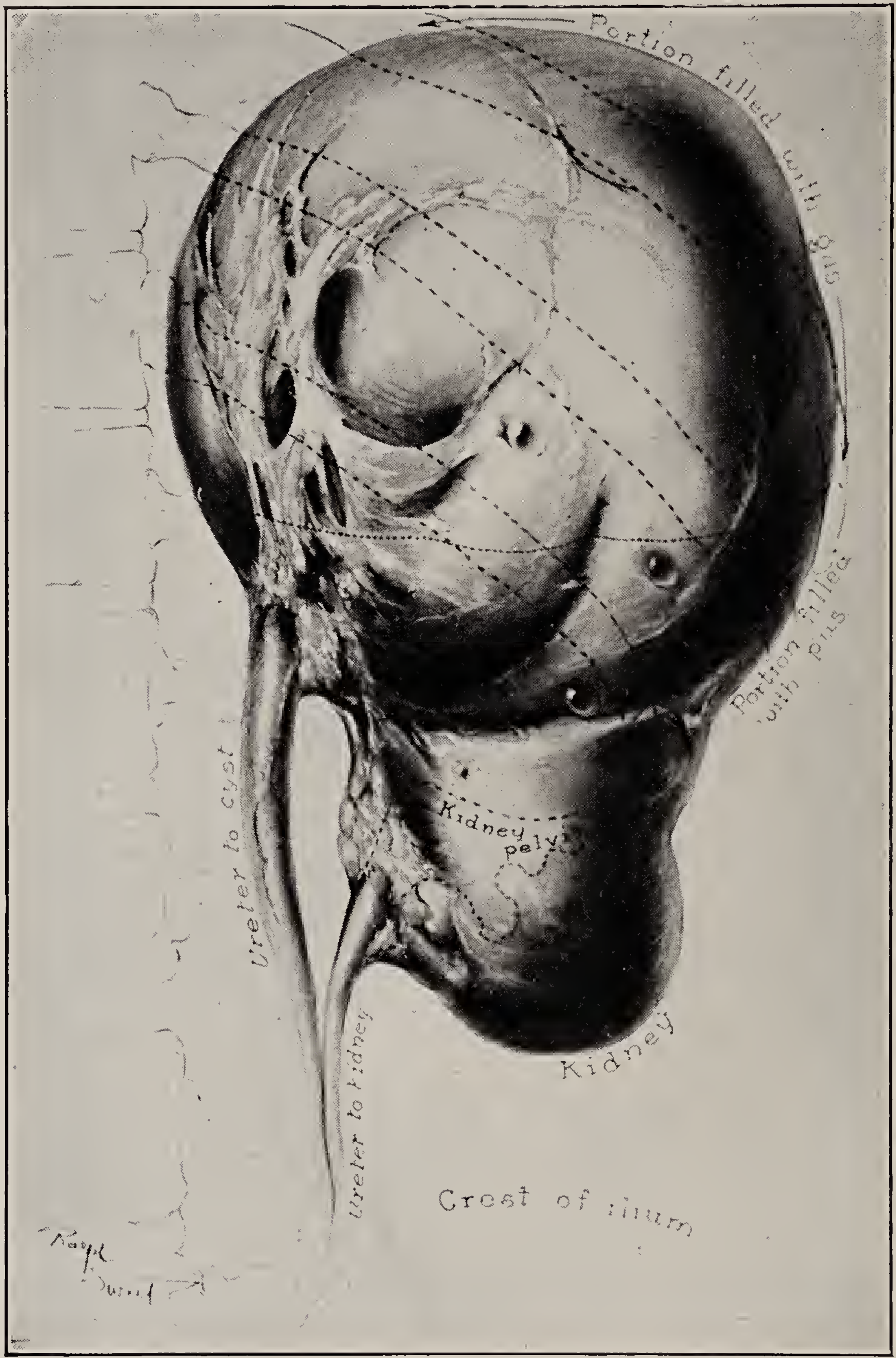

FIG. 52b. Illustration of pneumonephrotic kidney removed by operation. The renal mass consisted of a double kidney made up as follows: a superior portion formed by a huge hydronephrotic sac and hydroureter filled with air and pus with entire destruction of parenchyma, and a smaller inferior portion made up of an atrophic renal mass containing cortical abscesses, the pelvis and cortex of which were flattened out by the distended upper portion.

RENAL FIXATION. A NEW SIGN FOR THE ROENTGENOGRAPHIC DIAGNOSIS OF PERINEPHRITIC ABSCESS, PERINEPHRITIS, RENAL CARBUNCLE, AND CORTICAL ABSCESS OF THE KIDNEY

In working out the roentgenographic evidence of renal mobility during the past 17 years, it was repeatedly observed that lack of renal mobility, as evidenced by making a ureteropyelogram in the standing posture, occurred in suppurative lesions of the renal cortex as well as in suppurative and non-suppurative perinephritis. In working out this sign in all suspected cases of cortical and perirenal suppurative processes, we found it to be so constant that, when considered with the clinical history and other positive findings, it could be regarded as pathognomic. The authenticity of our observations has been repeatedly corroborated at operation and at autopsy.

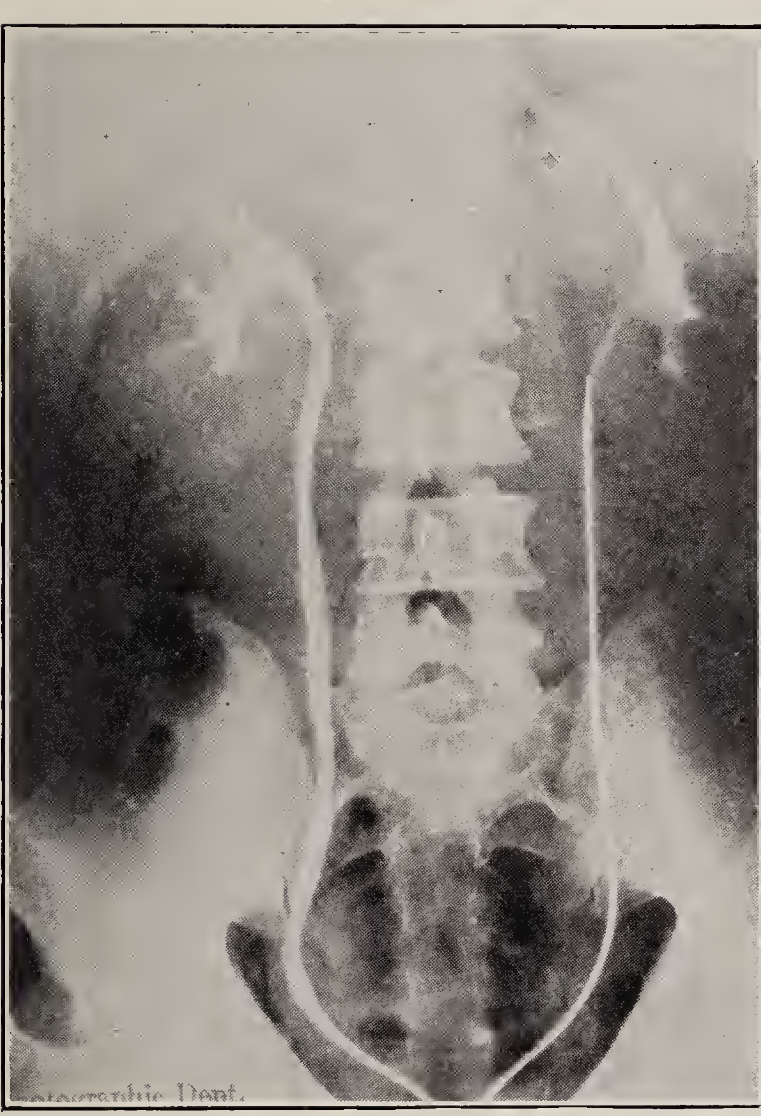

Fig. 53a. Horizontal pyelogram of patient, presenting fever, leucocytosis with pain, swelling and tenderness in region of right kidney due to perinephritic abscess.

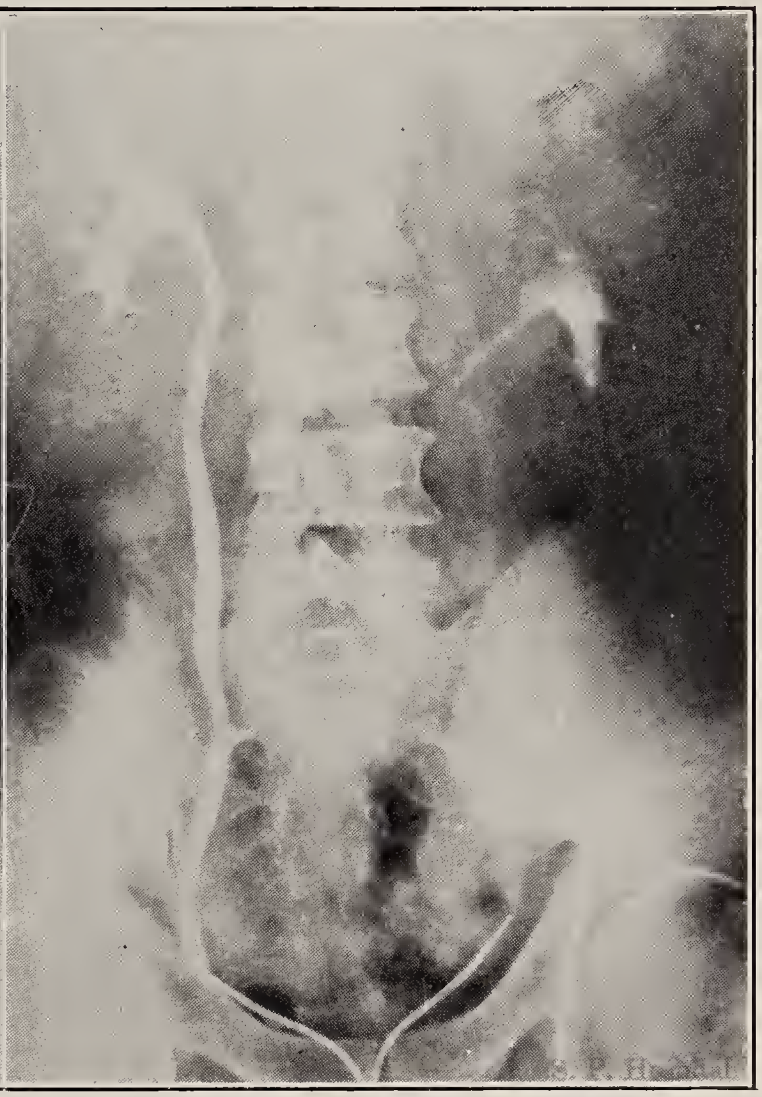

Fig. 53b. Vertical pyelogram of same patient demonstrating our positive roentgenological sign of perinephritic abscess-fixation of the kidney.

There are certain technical points which must be rigidly carried out in order to detect the author's sign. All pyelograms must be made in the Trendelenburg, horizontal, and vertical positions, and sometimes the lateral and ventral as well. It is essential that the compressing band, commonly used in conjunction with taking films with the Potter-Buckey diaphragm, should be released when the patient is placed in the standing posture. This point is sometimes overlooked, with the result that an unanchored kidney might be prevented from making its downward excursion and this could lead to an erroneous conclusion. To eliminate this possibility, we support the patient in the upright posture by the use of a second band that is attached to the upper portion of the table and extends in front of the chest. One must see that the patient is placed in the upright posture and not in the reclining position obtained by so many of

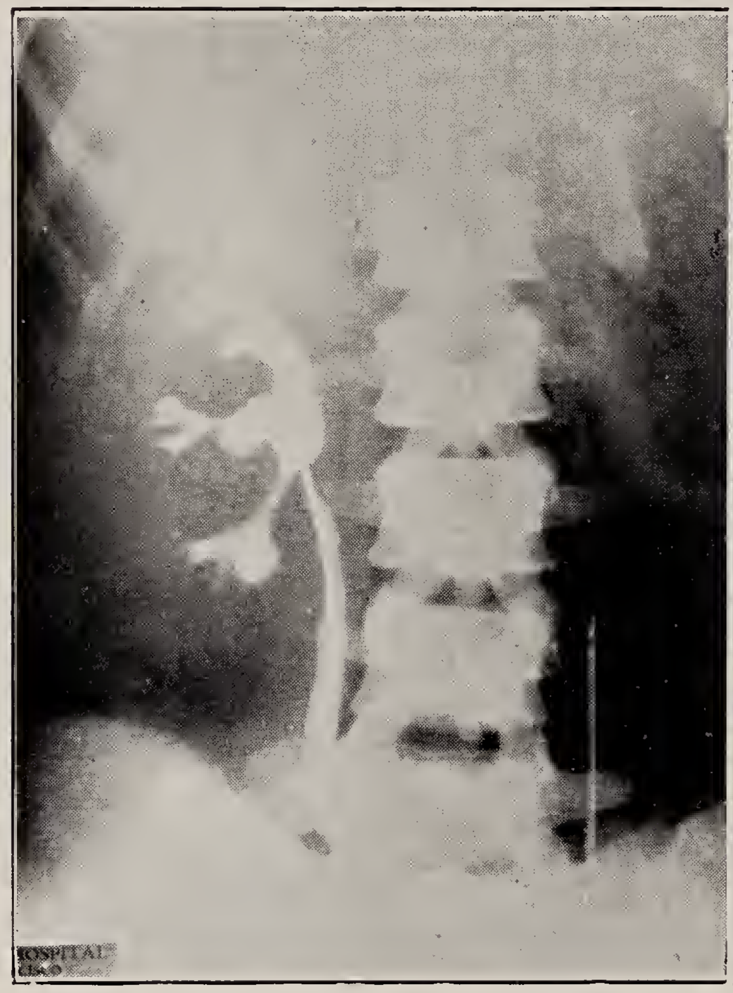

Fig. 54a. Pyelogram of right kidney in horizontal position in a girl, aged 13, presenting solitary abscess of kidney and perinephritic abscess secondary to stye in the eye.

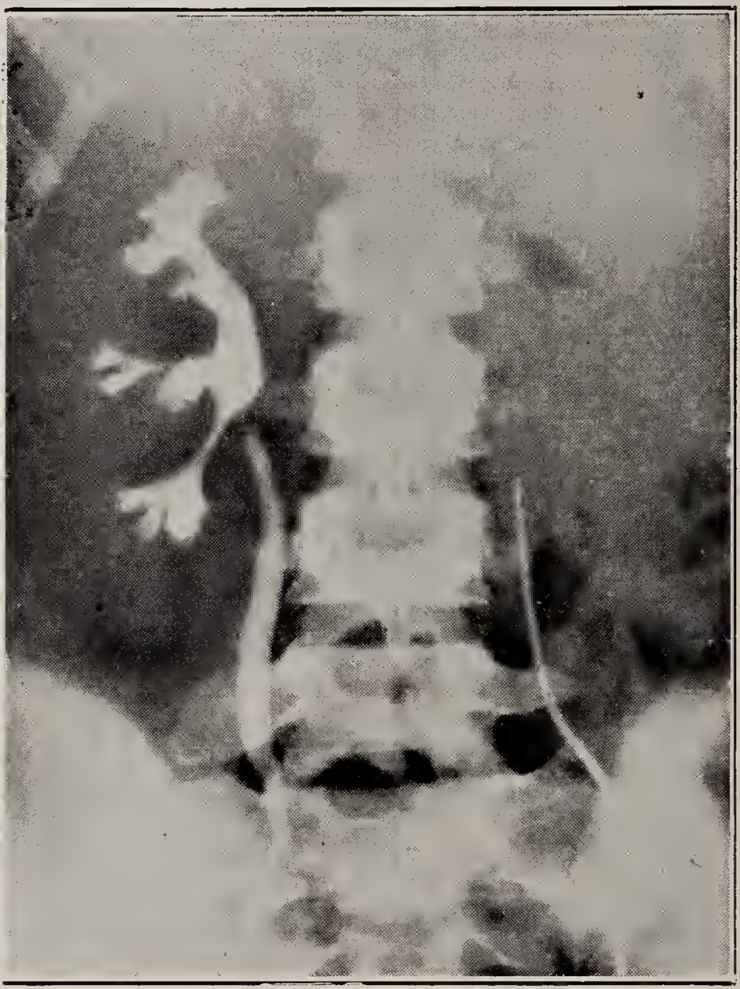

Fig. 54b. Pyelogram in vertical position showing author's sign: lack of renal mobility due to fixation of the kidney which is always demonstrated by making a pyelogram in the vertical posture and is due to suppurative and non-suppurative perinephritis, renal carbuncle or cortical abscess of the kidney.

the cystoscopic tables now in use. We require the employment of tables which can be adjusted so that the patient can be placed in the standing

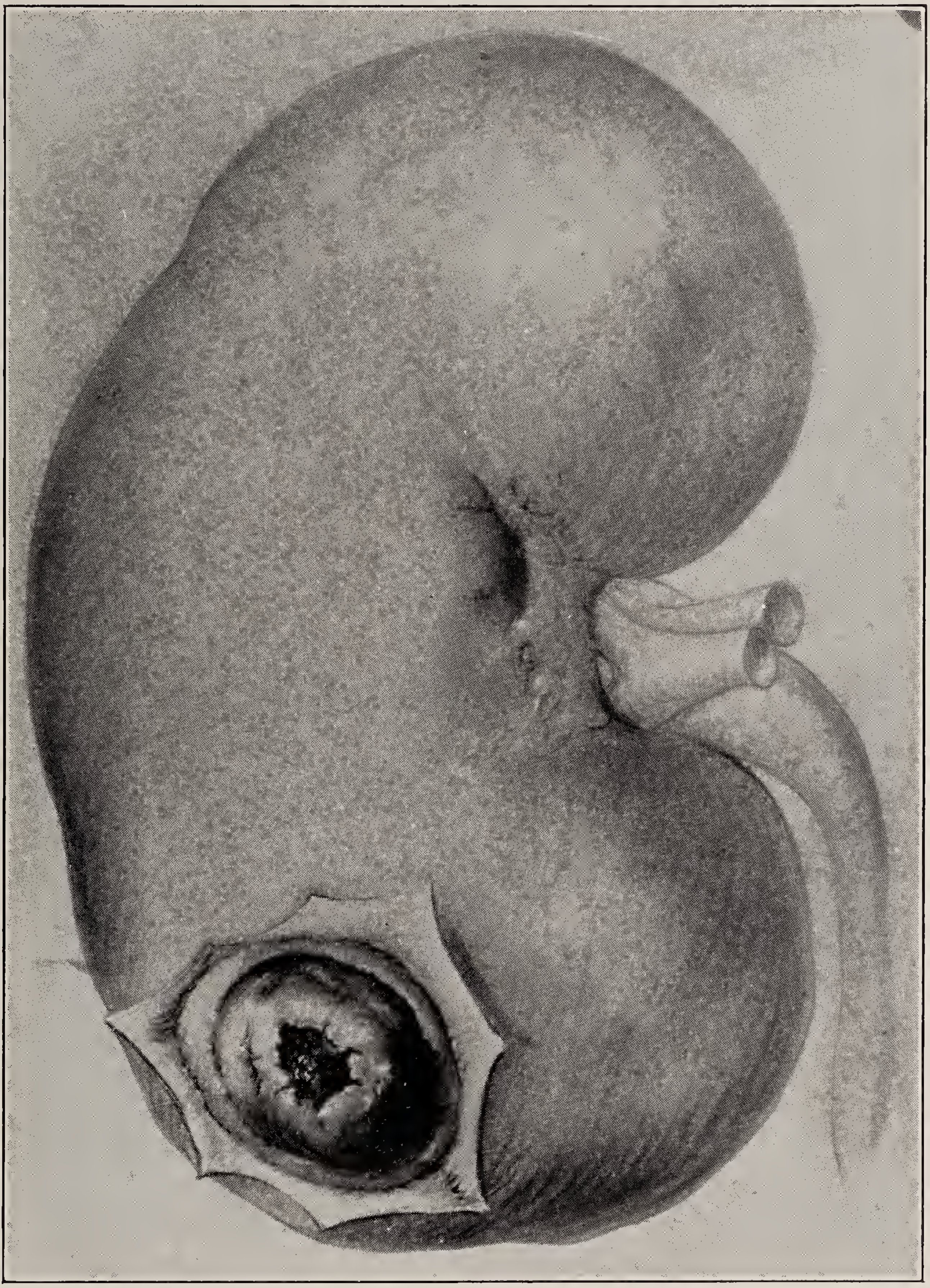

FIG. 54C. Illustration showing circumscribed abscess on anterior surface, lower pole of kidney, found at operation and relieved by drainage.

posture. To obtain this feature it might be necessary to modify certain tables. After the patient has been hoisted to the standing posture he is asked to breathe deeply a few times in order to give the kidney a chance to descend, provided it is not anchored in place. The film is then taken after the patient has exhaled. It is our custom to locate the position of the kidney by comparing the position of the lower or upper major calyx with a given point on the opposite vertebra. In cases of perinephritic abscess, perinephritis, renal carbuncle, and cortical abscess, the kidney is found to be anchored in place at a certain level, and it does not move in the Trendelenburg position or in the vertical lateral or ventral posture.

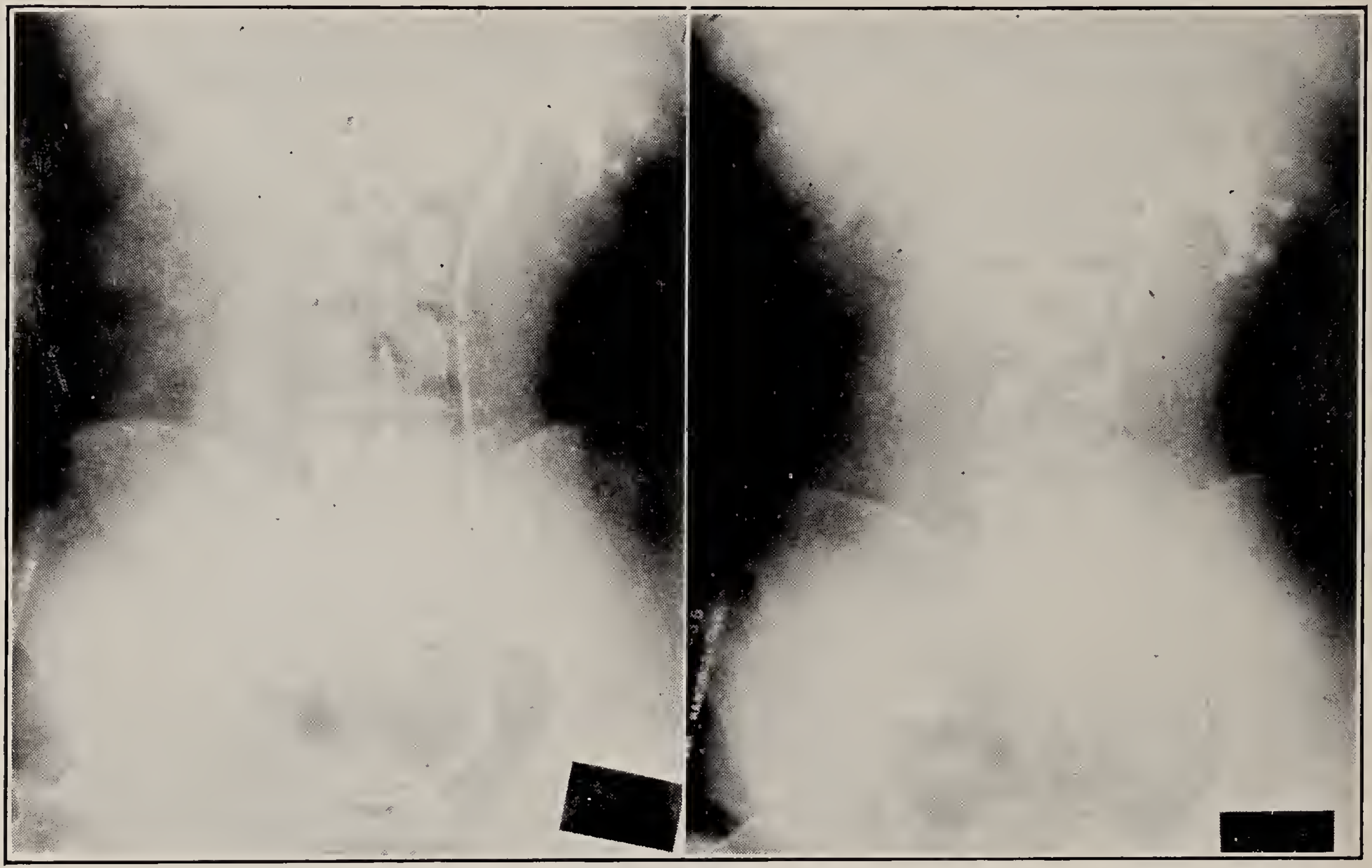

Fig. 55a. Ureteropyelogram of kidney presenting extensive perinephritis, taken in horizontal position, of a clergyman, aged 45, presenting persistent pain in solitary kidney ten years after nephrectomy of its fellow for pyonephrosis.

Fig. 55b. Ureteropyelogram made in vertical position demonstrating the author's sign: lack of renal mobility.

The major calyx will remain at the same level, as compared to a given point on the vertebra situated opposite to it, when the film is taken in the Trendelenburg and horizontal positions. If the technique is properly carried out, this renal fixation sign will be found to be constant and is of great value in assisting one to arrive at a correct diagnosis. The other positive x-ray findings — obscuration of the margin of the psoas muscle, lower ribs, transverse processes of the vertebrae and the kidney itself, curvature of the spine with convexity away from the abscess and displacement of the ureter anteriorly and laterally, while of unquestionable value — are variable and not constant. Renal fixation — like all other signs — is only of value when considered with the history, clinical course, and the presence of other general and special urological findings.

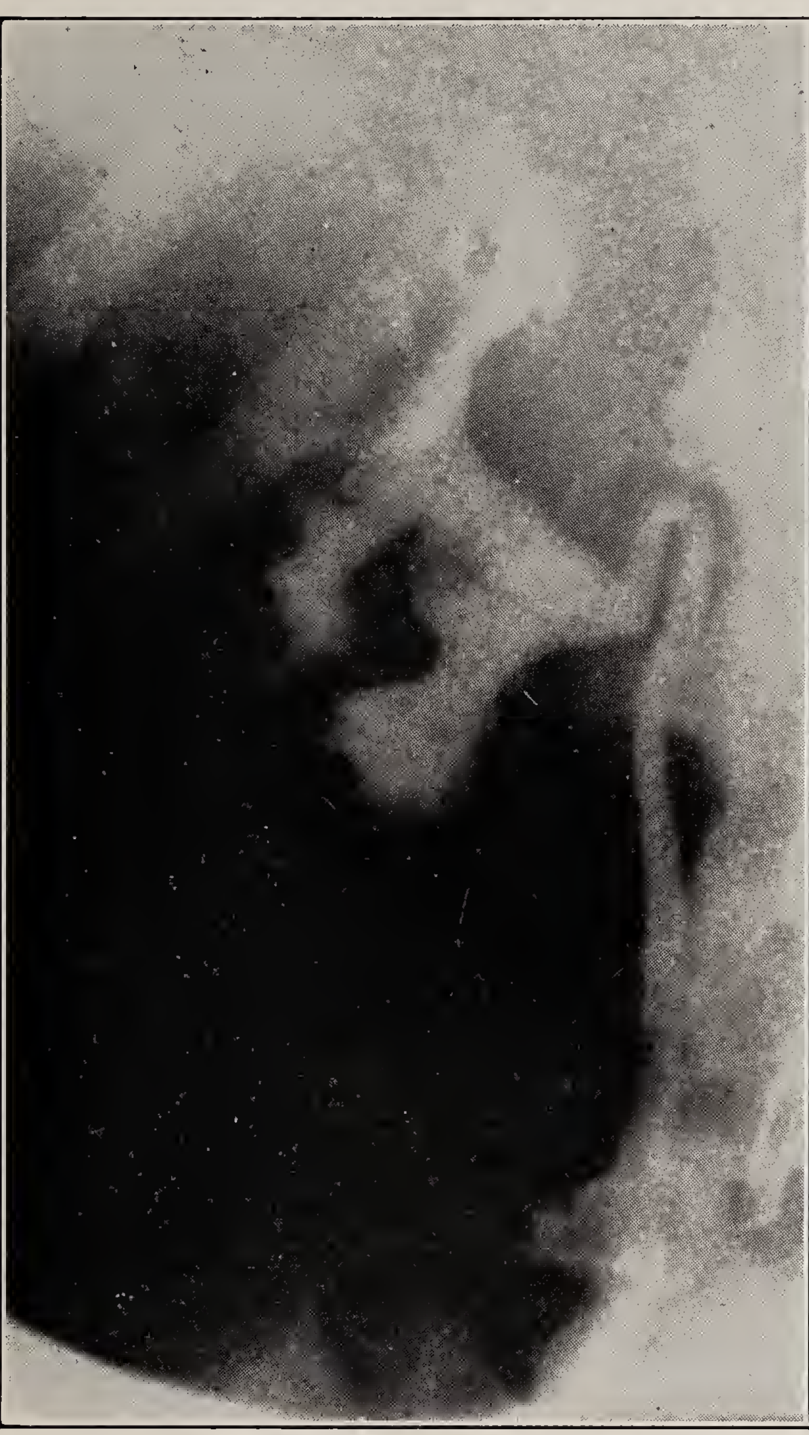

Fig. 56a. Pyelogram of carbuncle of the kidney taken in the horizontal position of female, aged 23, presenting fever, leucocytosis, loss of weight, et cetera with pain, swelling and tenderness in region of right kidney. Note elongation of upper calyx.

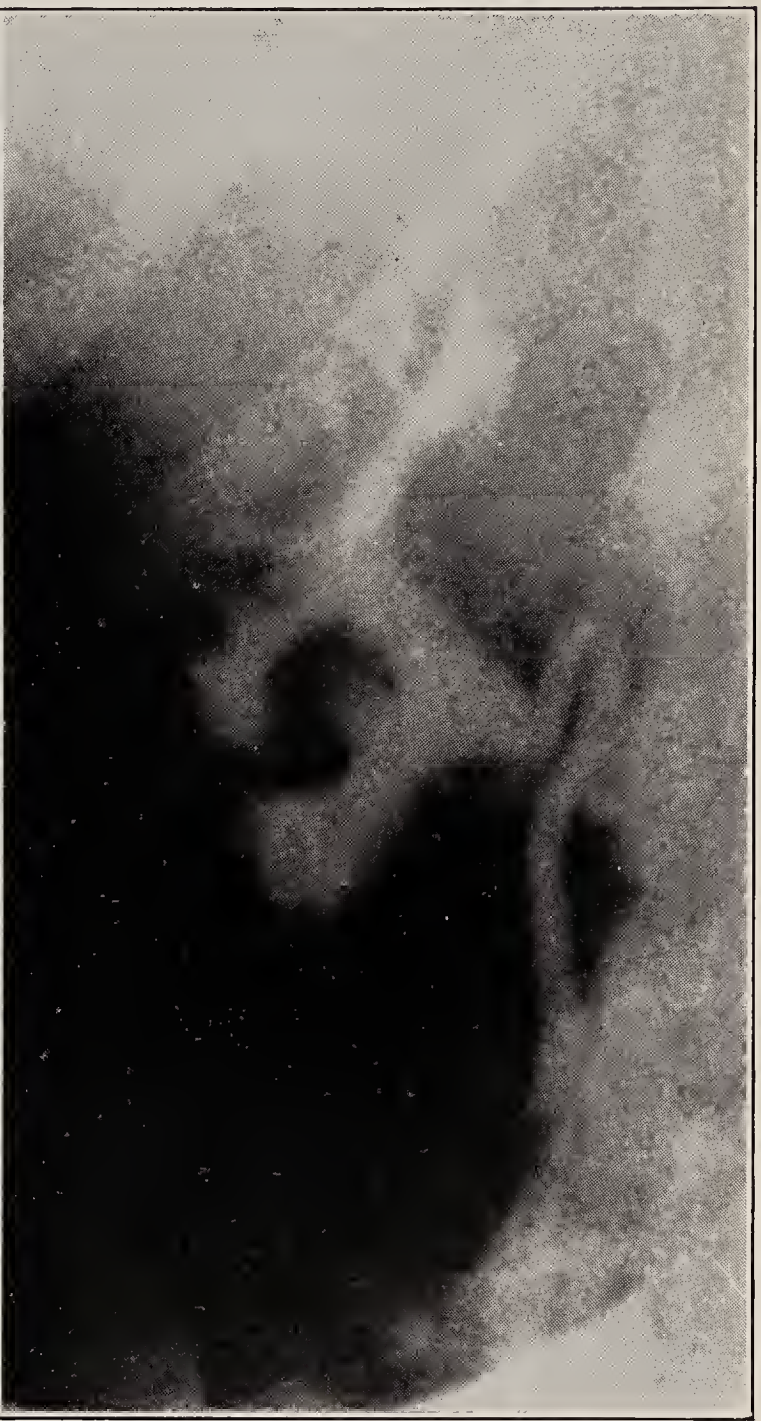

Fig. 56b. Pyelogram of same case in vertical position. Note author's sign: lack of normal descent of kidney.

Other corroborative roentgenographic evidence consists of changes in the kidney outline observed in the plain film and is due to tumefaction produced by large abscesses or carbuncle. In making the pyelogram, there might be elongation of a calyx by pressure of a nearby carbuncle or abscess.

ROENTGENOGRAPHY OF THE BLADDER, PROSTATE AND URETHRA

Plain films of the lower urinary tract give one an opportunity of detecting calculi and foreign bodies situated in the bladder and urethra and are of particular value in cases in which cystoscopy is contra-indicated. Carefully taken films may show the actual size, contour and position of the prostate, verifying palpatory findings per rectum, and the vesical encroachment that might have been demonstrated by cysto-urethroscopic examination.

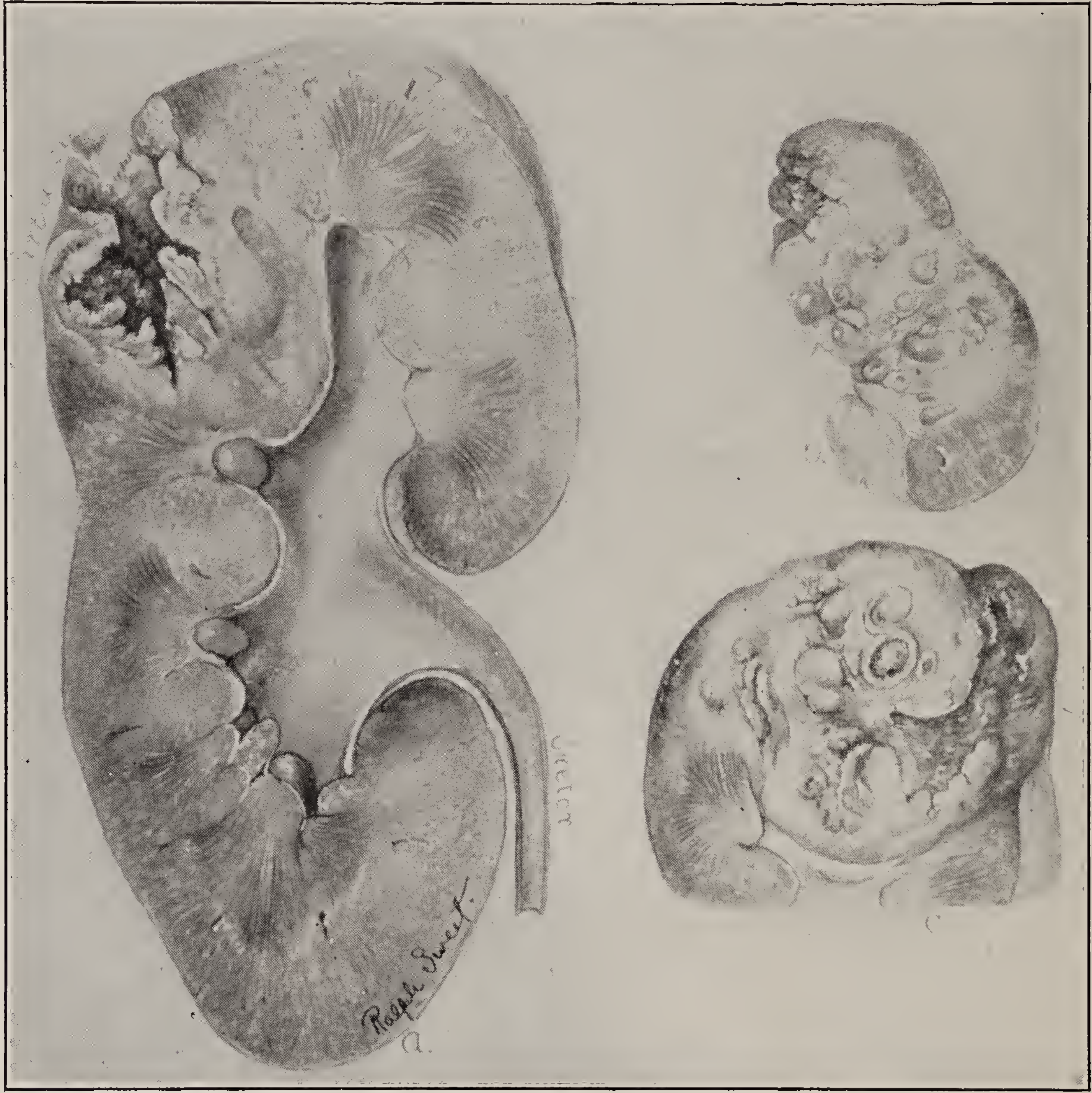

Fig. 56c. Sagittal section of kidney removed at operation showing encroachment of upper primary calyx by a carbuncle with corresponding elongation. Nephrectomy with relief.

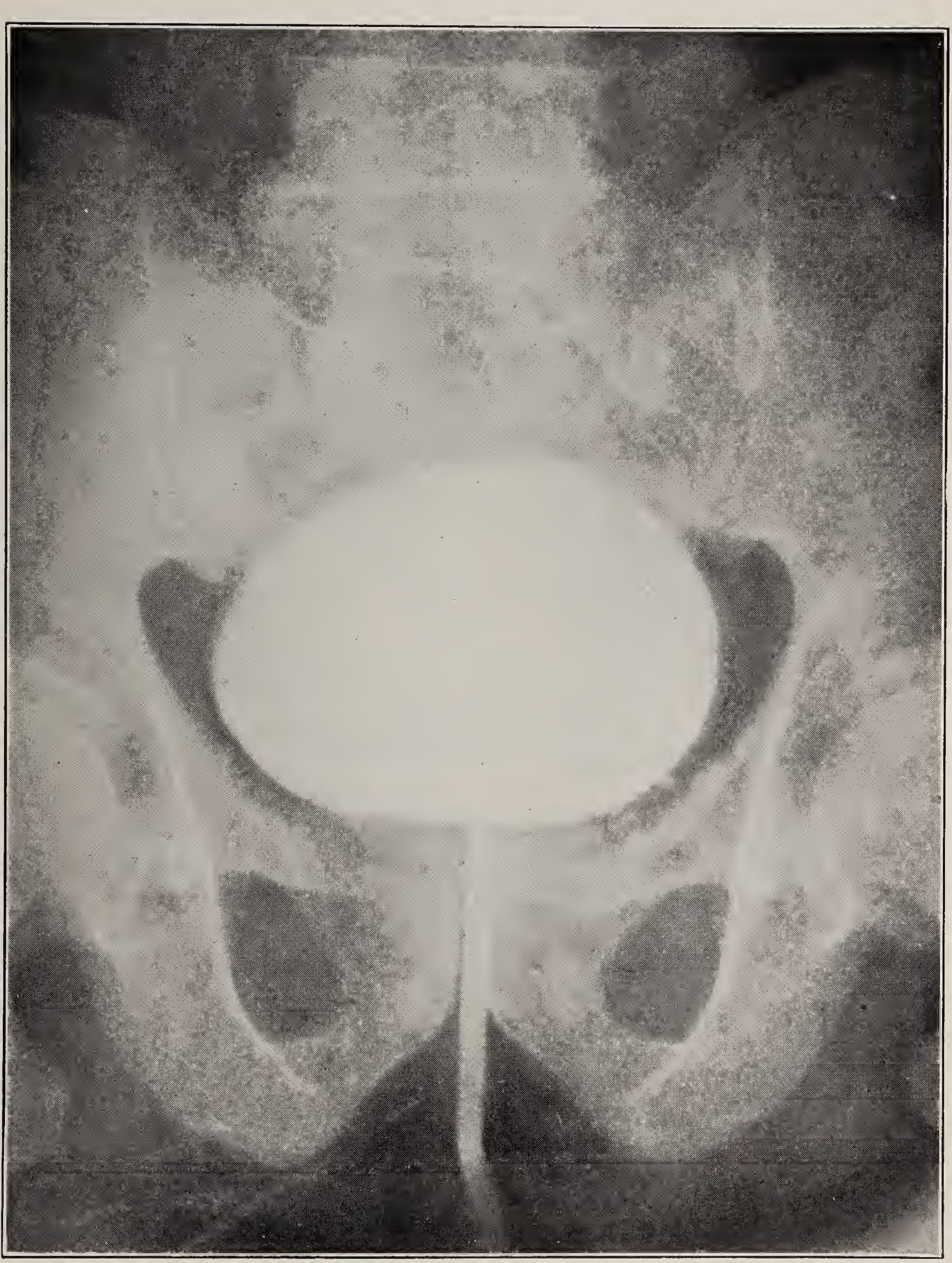

FIG. 57. Cystogram showing normal bladder outline.

Cystography. Cystography consists of the injection of an opaque medium into the bladder, permitting one to demonstrate the contour and size of this viscus and to detect any diverticula that may be present. One must be careful to select a medium that is not toxic nor irritating to the mucus membrane, such as sodium iodide, silver iodide, or lipiodol. The latter has been recently introduced. Being an oily substance it is not miscible with urine, but as the bladder can be previously emptied through a catheter this objection is readily overcome. Because of the danger of rupture, in certain cases presenting advanced tubercular and non-tubercular ulcerations of the bladder, cystography should not be performed. In some instances ureteral reflux from the bladder into the kidney may occur and in injecting the bladder the outline of the ureter and kidney pelvis may be obtained in one film. This is facilitated by placing the patient in the Trendelenburg position.

Diagnosis by cystography. By employing cystography the size, shape and position of the bladder are actually seen. Pressure defects in its contour, due to intra-vesical encroachment caused by tumor or abscess formation in adjacent organs, are also clearly demonstrated. Diverticula are also shown. When they are particularly large or laterally placed they are readily seen in injecting the bladder. In other cases it is necessary to take a film in the axial position (i.e. sitting up at 75 degrees) or by emptying the bladder of the opaque solution and reinflating it with air. As the bladder empties the opening of the diverticulum frequently closes, retaining the injected opaque medium within, which stands out separately in the second film, demonstrating its actual size and position. Fistulae connecting the bladder with the intestines, uterus, vagina, or rectum can also be demonstrated. An opaque catheter is inserted into the fistula and its course determined by the position taken by the catheter. Likewise, injection of the bladder and taking the film in the anterior posterior and lateral positions may demonstrate its position and course. Bladder neoplasms, when sufficiently increased in size, will cause an actual pressure defect in the bladder wall. The careful use of the cysto-urethroscope may enable one to visualize these various lesions of the bladder and urethra. However, careful employment of cystography will check these observations and in some obscure cases give considerable aid in diagnosis.

Fluoroscopic examination of the bladder. Fluoroscopic examination of the bladder consists in observing the filling and emptying of the normal and pathological bladder under the screen. One can actually observe the physiological mechanism of normal micturition, and likewise the emptying of the partly obstructed bladder can be clearly seen. The

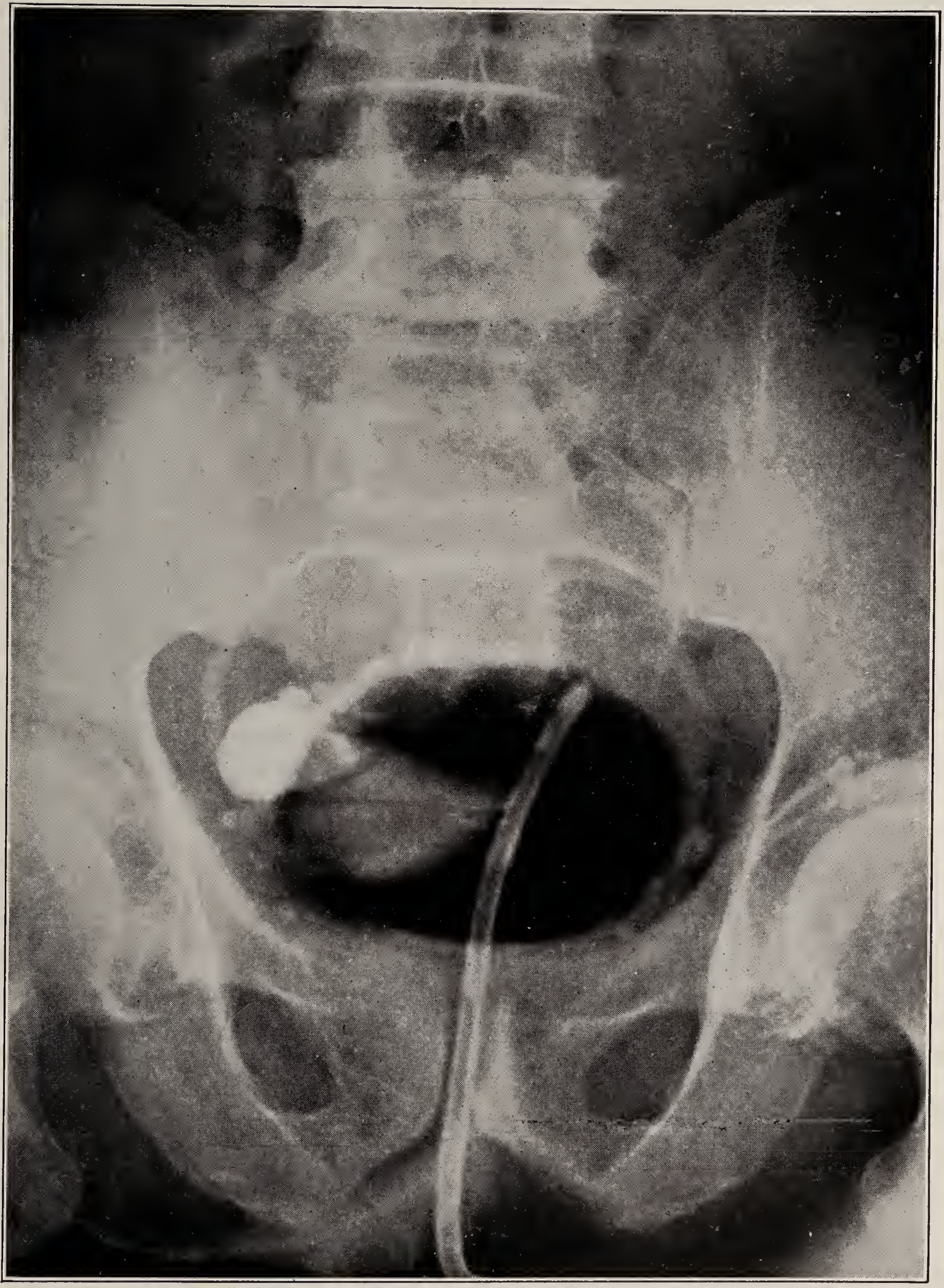

Fig. 58. Same case after evacuation per catheter and reinjection with air, showing diverticulum of bladder on right side.

filling and emptying of diverticula can be observed. By employing the fluoroscope one can actually observe the engagement and crushing of bladder stones with the lithotrite. This enables one actually to control the engagement of calculi by the jaws of the lithotrite. The indiscriminate use of this procedure is not to be advised, owing to the possibility of damage to the germinal epithelium.

Urethrography. Urethrography consists in the injection of the urethra with an opaque medium demonstrating the size, course and any pathological changes that may occur therein. Although the urethra can be accurately inspected by the use of the modern cysto-urethroscope it may aid in the demonstration of certain obscure conditions. Lipiodol is an excellent medium for this purpose. It is non-irritating to the mucous membrane and casts an excellent shadow. A film should be taken in the anterior posterior, lateral, and oblique position, the body being placed at an angle of 45 degrees. Good plain films will demonstrate calculi and these can be definitely proven by injecting the urethra. Diverticula and fistulae leading to adjacent organs such as the rectum, uterus or vagina can be clearly demonstrated, and the narrowing due to neoplasms and malformations actually recorded.

Differential diagnosis. The careful and intelligent employment of roentgenological examination of the urinary tract not only reveals pathological conditions occurring in the kidney, ureters and bladder, but may also aid one in the detection of lesions in adjacent organs. Its employment will often elucidate obscure conditions and enable one to determine if the lesion is located in the urinary tract or elsewhere.

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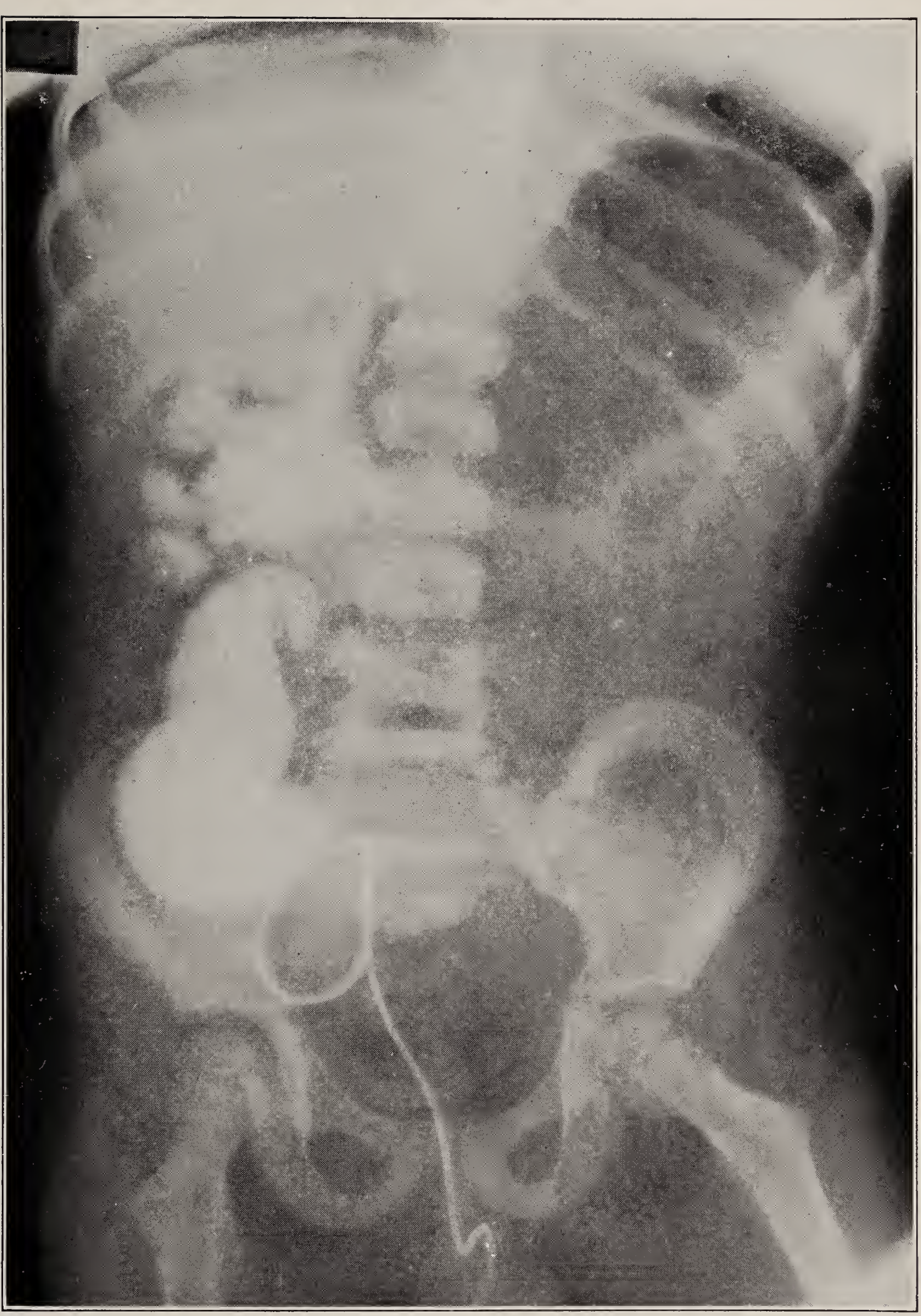

Fig. 59. Right uretero-pyelogram showing enormous hydroureter with elongation, and tortuosity, and extensive hydronephrosis.

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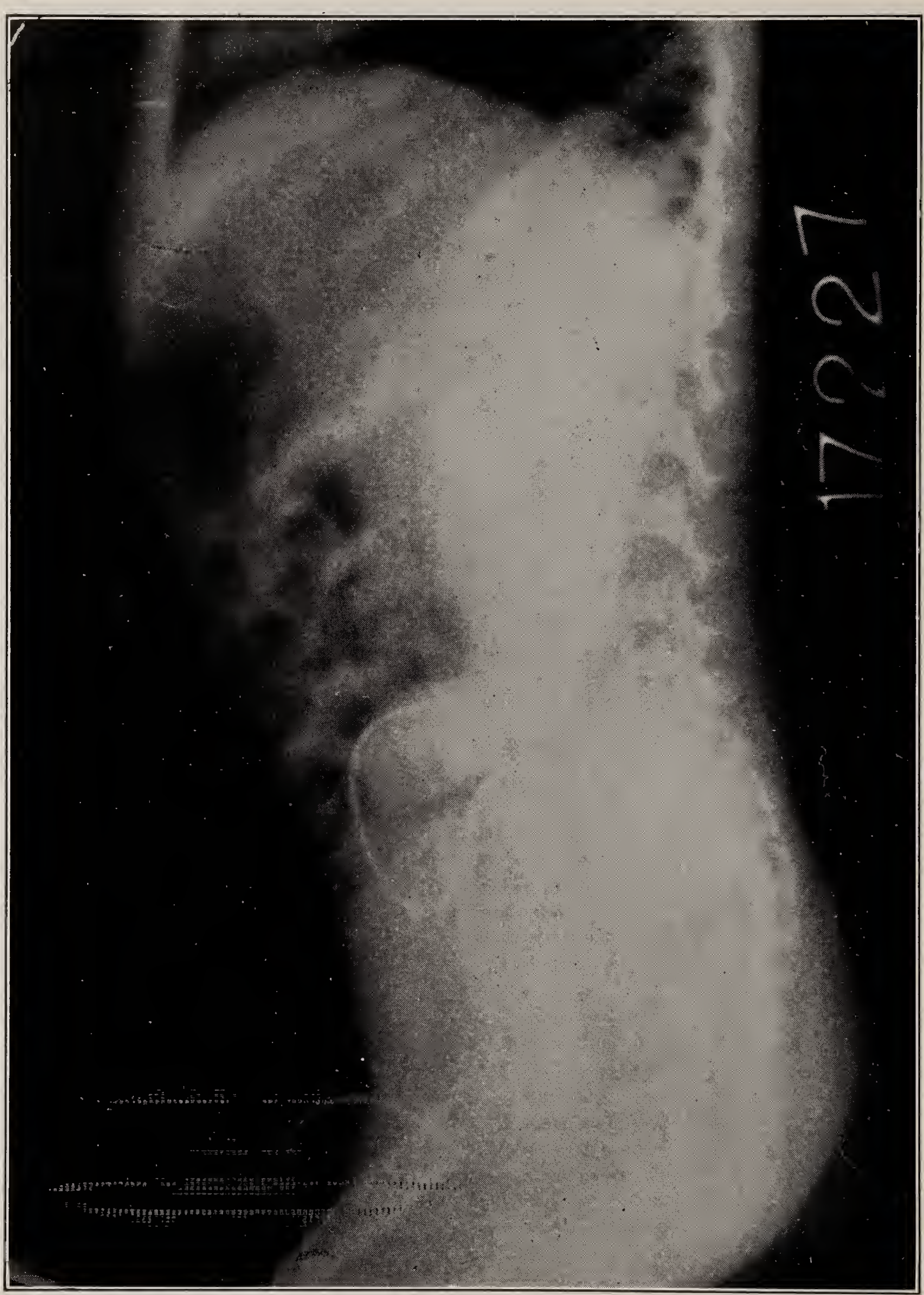

FIG. 60. Lateral view of same case showing remarkable dilatation of ureter. (Boy, age 5, with valve obstruction of the posterior urethra.)

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EXCRETION UROGRAPHY WITH THE USE OF IOPAX (UROSELECTAN)

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HISTORICAL

The first attempts at excretion urography with the aid of the x-ray were made in 1923 by Rowntree and his coworkers[1] of the Mayo Clinic. They utilized a 10 per cent. solution of sodium iodide intravenously, and also per os. The urinary bladder, and in some cases the pelvis and ureter, could be demonstrated.

The following year Rosenstein and von Lichtenberg[2] reported their results, repeating the work of Rowntree and his coworkers with sodium iodide but in conjunction with perirenal pneumoradiography, the object of the latter procedure being to demarcate the kidney shadow against that of the conducting system in an attempt to more clearly define the outline of the calices, pelvis, and ureter.

In the same year Volkmann[3] published his observations with the use of different halogen compounds; he found the intravenous injection of a 10 per cent. solution of sodium iodide to be most suitable.

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Lenarduzzi and Pecco[4] tied off the ureter and injected sodium iodide intravenously in animals, obtaining positive roentgenograms of the kidney pelvis and ureter.

Hryntschak[5] presented his investigations along these lines with the use of a large series of bromine and iodine compounds, some of which were aromatic in nature. In a number of his experiments he simultaneously employed an adjuvant, such as caffein, urea, pituitary extract, and atropin in order to influence excretion as well as the dynamics of the pelvis and ureter. He obtained some positive results in animals and in one female patient. In his conclusions he stated that, although two and a half years ago he had been able to secure useful intravenous pyelograms in a few instances, the method had by no means met the conditions set forth by him. However, he expressed the hope of accomplishing his aims by continued investigations.

At the Urological Congress in Munich, and in a publication, Ziegler and Köhler[6, 7] reported their results with the oral administration of 10 grams of sodium iodide and 10 grams of urea in milk, simultaneously applying compression over the sacro-iliac articulation through the abdominal wall by means of a special apparatus.

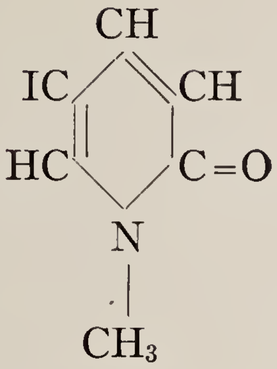
All the investigators who had utilized the halogen compounds found that these could not be given in sufficiently large quantities to be of any practical value for excretion urography, though under favorable conditions, in occasional cases, the kidney pelves, calices, and ureters could be made out.

The first to really achieve practical results by means of the intravenous use of a combination of sodium iodide and urea, called "Pyelognost" ($NaI, CO(NH_2)_2$), was Roseno[8]. According to some reports, it has been stated that the substance employed by him has frequently been associated with reactions. The visualization of the urinary tract, however, has in most cases been satisfactorily accomplished. Roseno also stressed the importance of the functional aspects of the problem.

DEVELOPMENTS LEADING TO UROSELECTAN FOR EXCRETION UROGRAPHY

A substance named "Selectan Neutral," synthesized by Professors Binz and Räth, was being investigated for its efficacy in the therapeusis of streptococcus infections in the clinic of Professor Lichtwitz of Altona, Germany.

The present work (Swick[9]), which resulted from the thought that this substance might be applicable for x-ray purposes because of its iodine



content (54 per cent.) and its excretion through the kidney and into the bile, was begun in 1928 in that clinic. The intravenous injection of the drug in rabbits demonstrated the fact that the kidney parenchyma and urinary bladder could be visualized; the pelvis and ureter, on the other hand, were poorly seen. Ligation of the latter did bring the upper tract well into view. Simultaneous studies of its excretion, limited to determinations of the iodine component, revealed about 75 to 80 per cent. of the calculated injected iodine in the urine in from twelve to sixteen hours. 0.2 grams of the compound per kilogram of body weight could be administered intravenously to the rabbit without any demonstrable ill effects; 0.33 grams per kilogram produced transient generalized disturbances. Because of marked individual differences in man, the quantity administered was far below the calculated one. The adult received 6 grams of substance. Headache, nausea, vomiting, generalized discomfort, and, in two cases, transient diplopia were disturbing factors. The oral and rectal administration of this drug in the dose given also yielded similar roentgenologic results and toxic manifestations. In all cases the urinary bladder was seen; the kidney parenchyma appeared to be more clearly defined. In man, the upper urinary tract was outlined only after artificially obstructing the ureter by the introduction of a bougie at the time of maximal excretion. The attained results, though not sufficiently good for purposes of excretion urography, were encouraging and pointed to the possibilities of further development.

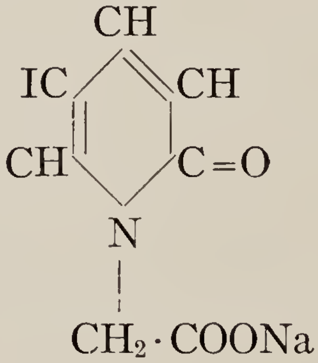
The author's experience with this substance, therefore, brought out the need for a modification possessing better tolerance, greater solubility, and a higher iodine content, so that a larger dose could be administered and a higher concentration of the excreted iodine component be hoped for. The results and observations were presented at a conference with Professors Binz and Lichtwitz. Professor Binz felt that the needs could be fulfilled, and furnished several compounds belonging to the Selectan group, synthesized by him and Professor Räth[10] at an earlier date.

Thereafter, the author's investigations[9] were continued on the Urological Service of Professor von Lichtenberg in Berlin, utilizing at first the original

Selectan Neutral with the already described reactions, and then two additional insoluble compounds of the Selectan family. The latter substances had to be administered by mouth and yielded negative results. Only in one case, that of a stone obstruction of the ureter about one inch below the uretero-pelvic junction, was a useful roentgenogram of the pelvis and ureter above the stone obtained with the use of Selectan Neutral. Finally, when Professor Binz supplied another member of that group, which proved to be soluble and well tolerated, the clinically applicable and successful substance for excretion urography was secured. This preparation, which differs from the original Selectan Neutral in that the methyl radical is substituted by that of sodium acetate, was introduced abroad as Uroselectan. The compound proved to be free from all accompanying reactions, to have quite an extraordinary affinity for the kidney, and to be very soluble in water. Satisfactory roentgenograms could now be obtained, as reported at the German Urological Congress in Munich (Swick[9]). Professor von Lichtenberg[11, 12], who took up the subject at the same meeting, considered that which was presented a significant advance.

PROPERTIES OF UROSELECTAN

Uroselectan, or Iopax, as it is called in the United States, is the 5-Iodo-2-Pyridon-N-Acetate of Sodium, contains 42.2 per cent. iodine, is non-toxic, very soluble in water, and neutral in reaction. The iodine is stable and organically bound. Neither in the injected solution nor in its excreted form is iodine present in ionized state. Iodism has never been observed. The tolerance for this compound is exceedingly great. A rabbit would receive 3 grams per kilogram of body weight without any ill effects. The substance is excreted as such through the urinary tract, being recovered from the urine as a light yellow insoluble precipitate (the acid).



The recovery and identification of the excreted substance have been established in the following manner: The addition of a dilute mineral acid — HCl or H_2SO_4 — to urine containing the excreted soluble salt of Uroselectan results in the precipitation of the insoluble acid. The precipitating agent is added gradually until no more precipitation occurs. After one hour's settling, the insoluble acid is filtered by means of suction on a Buchner funnel, and is washed free from the precipitating agent with distilled water as determined by the silver nitrate test for the chloride-ion or barium chloride for the sulphate-ion. The residue is dried to a constant weight at 80 degrees C. For identification, a variety of samples of the urinary precipitate was analyzed for their iodine and nitrogen content; their acid equivalents and melting points were also determined. These were simultaneously controlled by comparison with similar determinations on precipitates obtained from clean manufacturer's samples of the sodium salt. The results are presented in Table 1.

TABLE 1. — *Analysis of Urine Containing Excreted Soluble Salt of 5-Iodo-2-Pyridon-N-Acetic Acid*

Sample	*Color*	*Nitrogen Determination Micro Dumas Method*	*Iodine Determination $Na_2CO_3 + NaNO_3$ Fusion Method*	*Iodine Determination Carius Method*	*Acid Equivalent*	*Melting Point Uncorrected*
Manufacturer sample	Light yellow white	4.99 %	46.77 %	46.37 %	277	235.5
Urine sample 1	Light yellow white	5.23 %	46.23 %	46.4 %	280	234
Urine sample 2	Slightly brown	5.04 %	46.31 %	47.98 %	Not done	Not done
Urine sample 3	Brown	5.29 %	46.65 %	50.1 %	279.5	235

Note: The determinations in columns 4, 5 and 6 represent averages. Theoretical iodine content, 45.5 per cent.; theoretical nitrogen content, 5.02 per cent.; theoretical acid equivalent, 279.

The brown color of the precipitate recovered from some of the urines is believed to be due to the admixture of urinary pigment, as shown in a former publication[9], in which it is also demonstrated that the precipitation is a quantitative one and that normally about 85 to 95 per cent. of the substance can be recovered from the urine within eight to twelve hours after the injection. Tables 2 and 3 illustrate the results of excretion from a case with good renal function and from one with poorly functioning kidneys.

TABLE 2. — *Quantitative Determination of Urine Specimen* *

Urine Specimen	*Volume, Cc.*	*Specific Gravity*	*Weight of Precipitated Substance, Gm.*	*Iodine Calculated from Substance, Gm.*	*Iodine Determination of Urine*
2 hours	850	1.014	19.79	9.004	9.6295
2 hours	200	1.034	9.395	4.275	4.76
2 hours	120	1.032	4.604	2.095	2.4578
2 hours	91	1.024	1.792	0.8154	1.0396
2 hours	93	1.014	No precipitate		
2 hours	150	1.008	No precipitate		
Total grams			35.581		17.889
Percentage of substance excretion					91.23 per cent.
Percentage of iodine excretion					95 per cent.

* A woman, 25, with good renal function; 50 Gm. of substance injected.

TABLE 3. — *Quantitative Analysis of Urine Specimen in a Case Presenting Poor Function* *

Urine Specimen	*Volume, Cc.*	*Specific Gravity*	*Weight of Precipitated Substance, Gm.*	*Iodine Calculated from Substance, Gm.*	*Iodine Determination of Urine, Gm.*
2 hours	335	1.019	6.70	3.05	3.12
2 hours	260	1.022	6.10	2.78	2.84
2 hours	145	1.025	3.86	1.76	1.82
2 hours	160	1.025	3.56	1.62	1.79
2 hours	138	1.022	2.71	1.23	1.26
Total grams			22.93		10.83
Percentage of substance excretion					53 per cent.
Percentage of iodine excretion					52 per cent.

* A woman, aged 42; 55.5 Gm. of substance injected.

OTHER PREPARATIONS FOR EXCRETION UROGRAPHY

Since the advent of Uroselectan, several additional preparations have been developed for excretion urography. The clinical results with one of them, Skiodan (Abrodil), the sodium salt of iodo-methane sulphonic acid, synthesized by Ossenbeck and Tietze of the I. G. Farbenindustrie, have been reported by Bronner, Hecht and Schüller[13]. This substance (52 per cent. iodine) is distributed in sterile vials containing 20 grams dissolved in 50 cc. of solution. Another, from among a series clinically tested by von Lichtenberg[14], has been introduced comparatively recently for clinical use as Uroselectan B (Neo-Iopax), the disodium salt of N-methyl-3, 5-diiodo-4-pyridoxyl-2, 6-dicarboxylic acid, synthesized by Dohrn and Biedrich of Schering-Kahlbaum. The latter compound (51.5 per cent. iodine) is prepared in ampules of 15 grams of substance dissolved in 20 cc. of solution. Both yield very satisfactory urograms, though some irritative reactions with the intravenous use of Neo-Iopax have been observed in the United States. Finally, the author has had the good fortune to have found an altogether new compound for excretion urography, the full account of which will be published in the near future.

SOME CONSIDERATIONS CONCERNING EXCRETION UROGRAPHY

It might be well, at this point, to enter into a general consideration of excretion urography as a diagnostic aid. Experience with this method is of relatively short duration. Yet, in the light of what knowledge has been accumulated, it may be deemed not only permissible, but indicated, to attempt to derive some general principles on the basis of these experiences and observations.

From discussions already presented, one gathers the impression that there is a tendency, in viewing the relative results obtained, to look upon excretion urography as a competitor of retrograde pyelography. Uppermost in the minds of some are: whether the former is capable of replacing the latter and whether it is superior or inferior. It appears, on the other hand, that the major points to be analyzed are the following:

1. Is this procedure attended by reactions detrimental to the patient?
2. What has this method to offer?
3. What are its shortcomings?
4. What are its indications?
5. What are its contraindications?

The brief outline of the properties presented above, as well as the clinical experiences with this drug, will serve to dismiss the first consideration. Aside from a moderate degree of generalized warmth, thirst, and occasional pain in the arm of injection, there has been no definite evidence of any toxic manifestations in the human.

With regard to the remaining questions, it is considered expedient to take the individual points in the discussion as part of a general presentation.

Excretion urography should be viewed as only one aid in urological diagnosis, and, as such, is not without its limitations. It cannot entirely supplant cystoscopy, ureteral catheterization, and retrograde pyelography, and must be viewed in each individual case in conjunction with other means of approach, such as the history, physical and laboratory findings. Where any doubt exists, it must be supplemented by cystoscopy and retrograde pyelography; and vice versa, where the latter procedures, because of mechanical reasons or the presence of infection, cannot be executed, excretion urography will be found of great value. Caution and reserve should be exercised in one's interpretation and final judgment in the evaluation of this method and the results obtained therefrom until far more exhaustive studies of this problem have been made. Even cystoscopy and retrograde pyelography, despite their years of existence, still have their defects. As an example, Figure 1 * demonstrates the intravenous urogram of a patient with a history of bilateral renal pain associated with fever, chills, frequency, urgency, and hematuria, who, on cystoscopy was found to have good indigo carmine excretion from both sides, twenty cubic centimeters retention in the left kidney pelvis, but none in the right. Accordingly, only a left retrograde pyelogram — the side with retention — was done, not expecting any abnormality of the right urinary tract. The intravenous picture, to our surprise, disclosed, aside from the slight dilatation of the left kidney pelvis incidental to a stone in its lower ureter, a huge hydronephrosis of the right renal pelvis.

RENAL FUNCTION AND EXCRETION UROGRAPHY

Because the mechanism of this type of visualization is based on excretion by the kidney parenchyma, one must of necessity discuss the question of renal function in relation to this method. A consideration of this phase will in addition aid one to develop, though in a very general way, a rationale for the interpretation and the evaluation of this procedure as a

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* It should be noted that this illustration is the intravenous urogram obtained with another substance, newly developed for excretion urography. It is chosen because it serves to illustrate the point at issue.

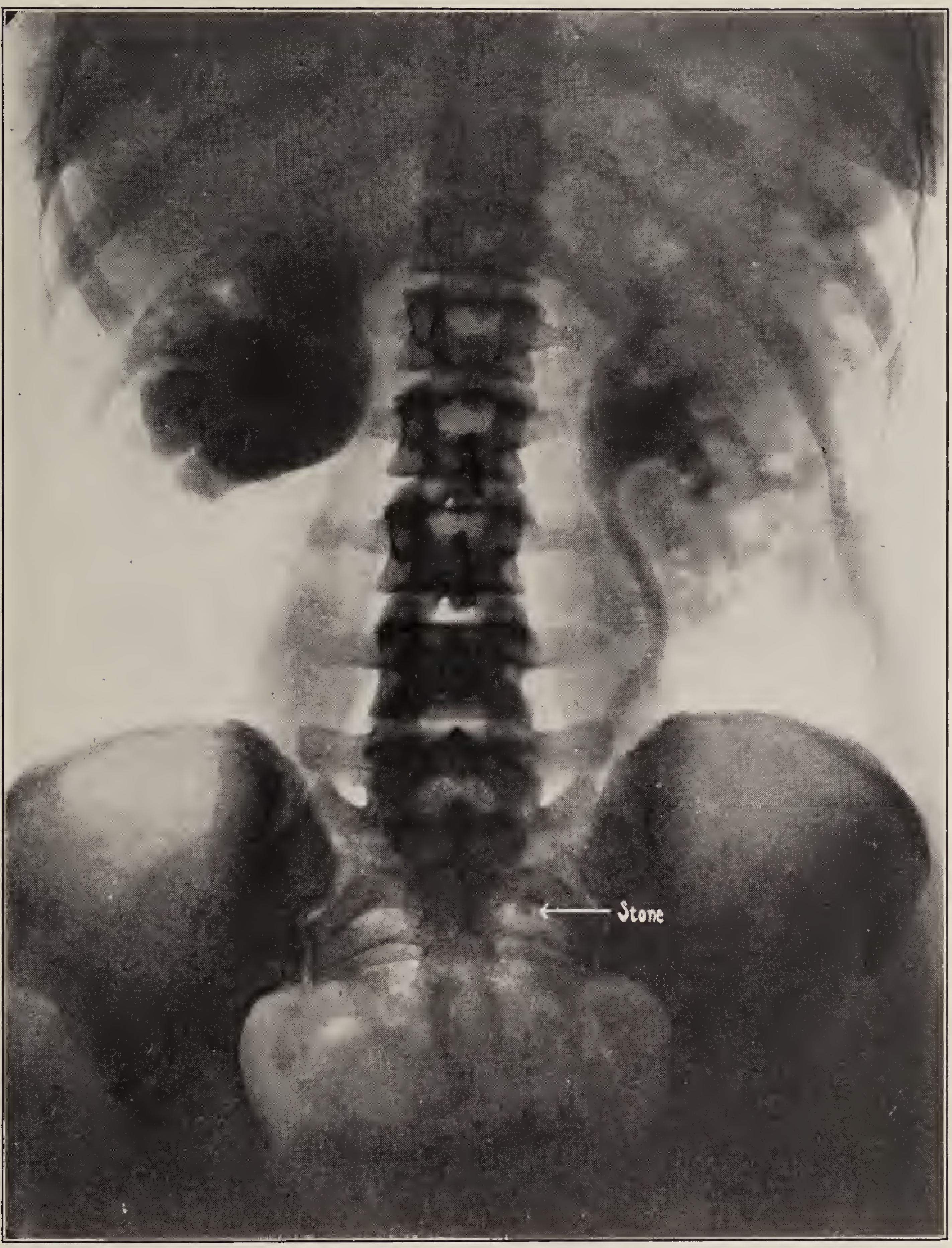

Fig. 1. Intravenous urogram, woman aged 29. Shows huge right hydronephrosis and non-visualization of the ureter. Diagnosis — trapped right kidney with aberrant vessels.

method of investigation. From the studies of excretion, it is observed that the normally functioning kidney possesses the ability to excrete this substance in relatively large quantities within a given short period. This may be characterized as the "thrust excretion ability of the normally functioning kidney" which is present during the first two hours. To illustrate: from about 45 to 65 per cent. of the total precipitable acid is recovered during the first two hours, about 20 to 30 per cent. in the next two, and the remainder subsequently. Figure 2 represents the curves of excretion of normally and those of poorly functioning kidneys. One notes that in the latter case the high level which obtains in the former is absent. It is obvious that poor or no visualization will be found in the poorly functioning kidney, since for roentgenologic visualization a certain concentration of the radio-opaque element, namely the iodine component, is necessary. Aside from the dose administered, that concentration depends also upon renal and extrarenal factors influencing renal excretion. In other words, broadly speaking, it may be stated that visualization, poor, or no visualization is dependent upon renal and extrarenal factors.

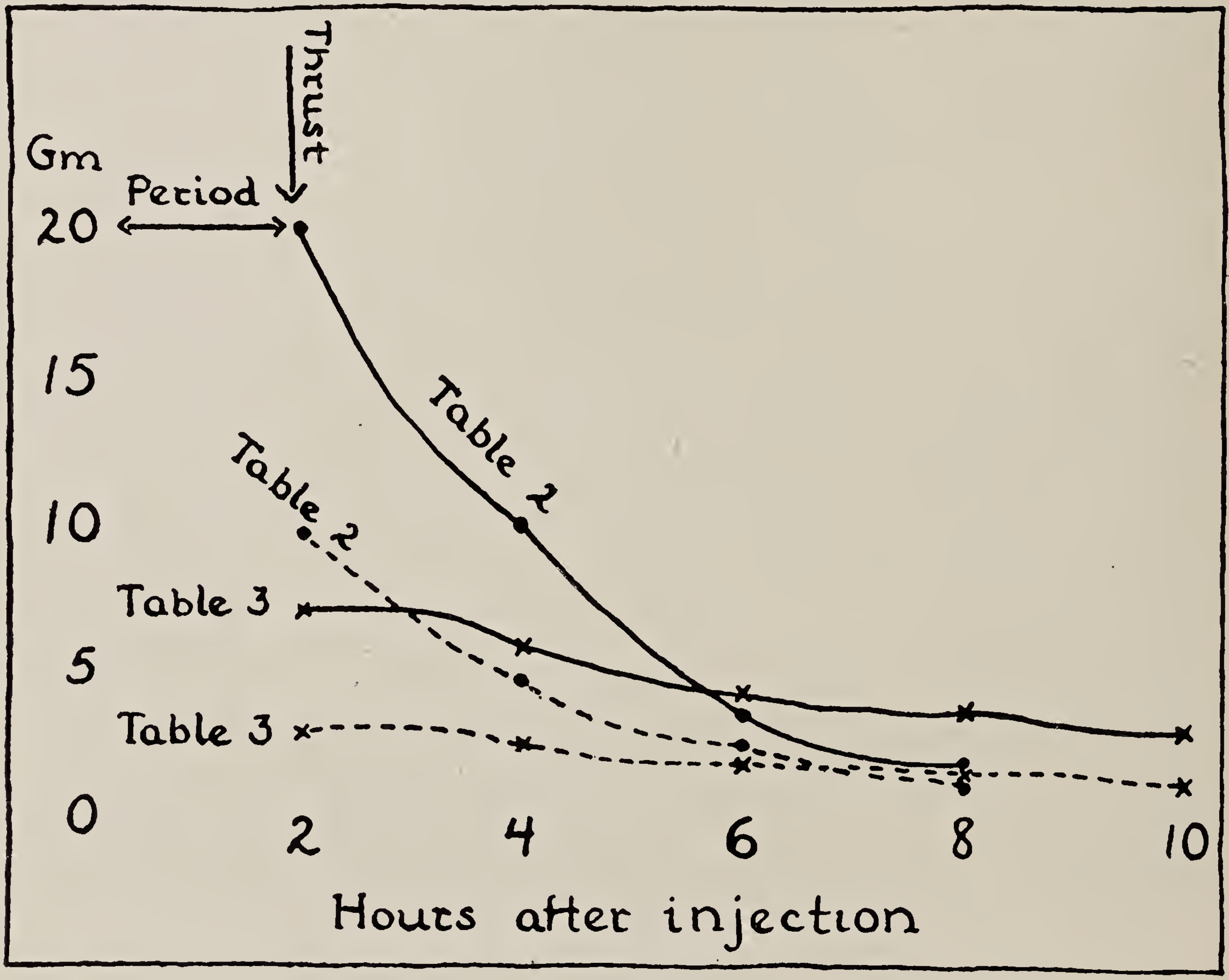

FIG. 2.

RENAL FUNCTION AND RADIOLOGIC FINDINGS IN HYDRONEPHROSIS

When, however, the additional mechanism of obstruction is present, visualization may be had although the height of excretion requisite under normal circumstances be absent, provided that excretion takes place. On the other hand, under the same circumstances but with normal excretion, intensification of the shadow results. Thus, in cases of hydronephrosis, despite the mere presence of comparatively little intact renal tissue, good visualization may often be encountered. This brings up an important consideration. In cases of hydronephrosis, the presence of functioning renal tissue, as evidenced by the radiologic findings, is no quantitative criterion nor one for determining the type of therapeutic procedure. The latter will depend upon the individual case, the pathologic-anatomic status, as well as upon the particular approach of the physician or surgeon in the case in question. The following examples illustrate this principle:

A thirteen-year-old boy, with a history of intermittent hematuria of one month's duration, showed by x-ray a calculus shadow in the right kidney region. Excretion urography, on March 28, 1930, visualized several large hydronephrotic sacculations on the right side. By cystoscopic examination no indigo carmine excretion could be seen from that side, though 15 cubic centimeters of urine containing 1.4 per cent. urea were obtained on aspiration. At operation a uniformly thick layer of good renal tissue was found. Accordingly, only a right nephrotomy and nephrostomy for the renal calculus were done. The post-operative course was one of infection. Another intravenous urogram, on June 7, 1930, revealed the old sacculations still present though apparently somewhat smaller and more irregular than before. A dilated ureter could now also be visualized. Because of the presence of infection and of the clinical pathological picture, the surgeon this time felt compelled to resort to a secondary nephrectomy; this, despite the presence of good renal function on that side as evidenced by the radiologic findings. Figures 5 and 6 demonstrate again the intense visualization obtained in another case of markedly developed congenital hydronephrosis incidental to an S-shaped trapped uretero-pelvic junction, even though only comparatively little intact renal tissue was found at operation.

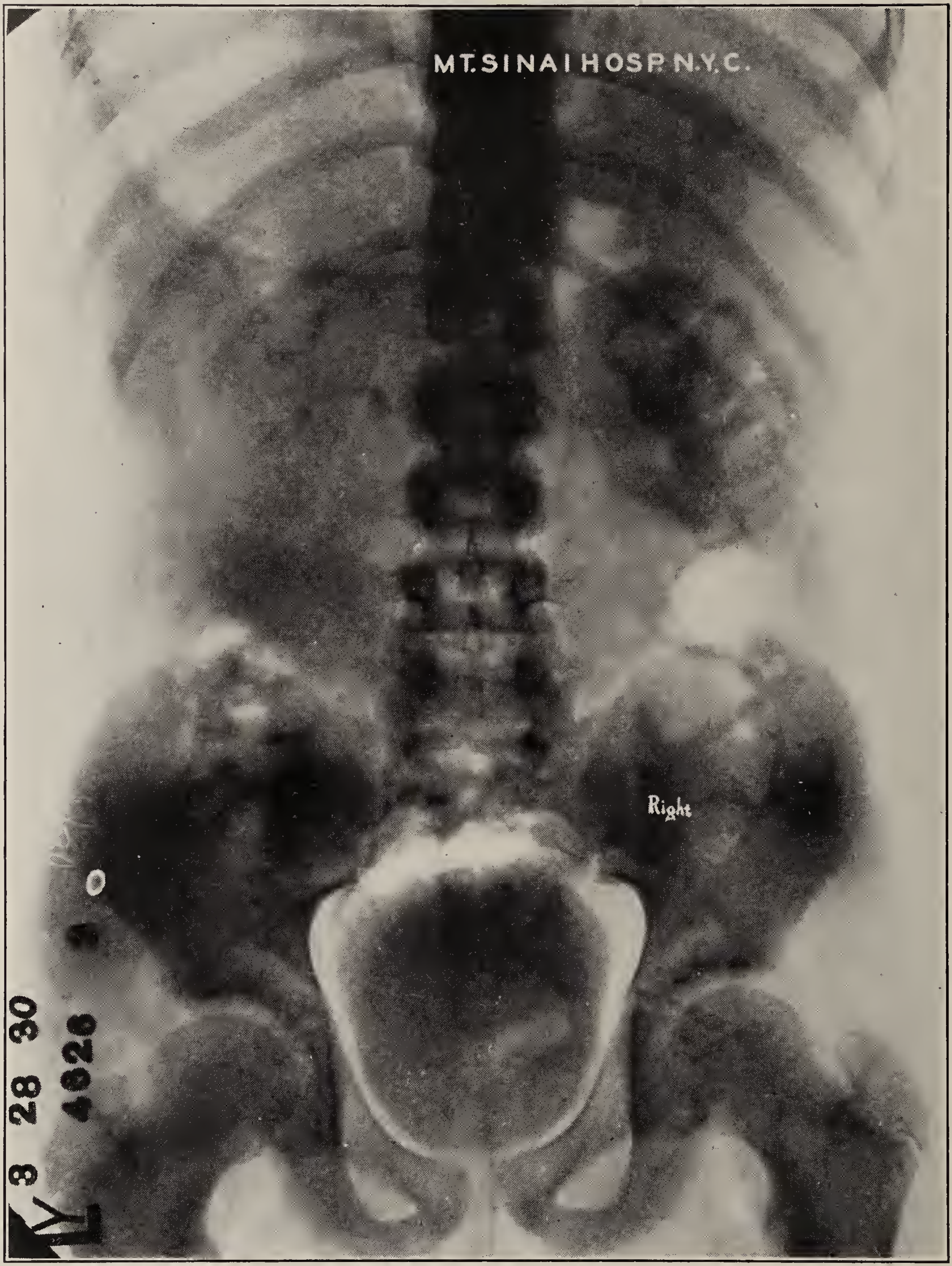

Fig. 3. Intravenous urogram of a boy, aged 13, with a history of intermittent hematuria and a calculus shadow by x-ray in the right kidney region, demonstrating several large sacculations of a right hydronephrosis, and a normal left urinary tract.

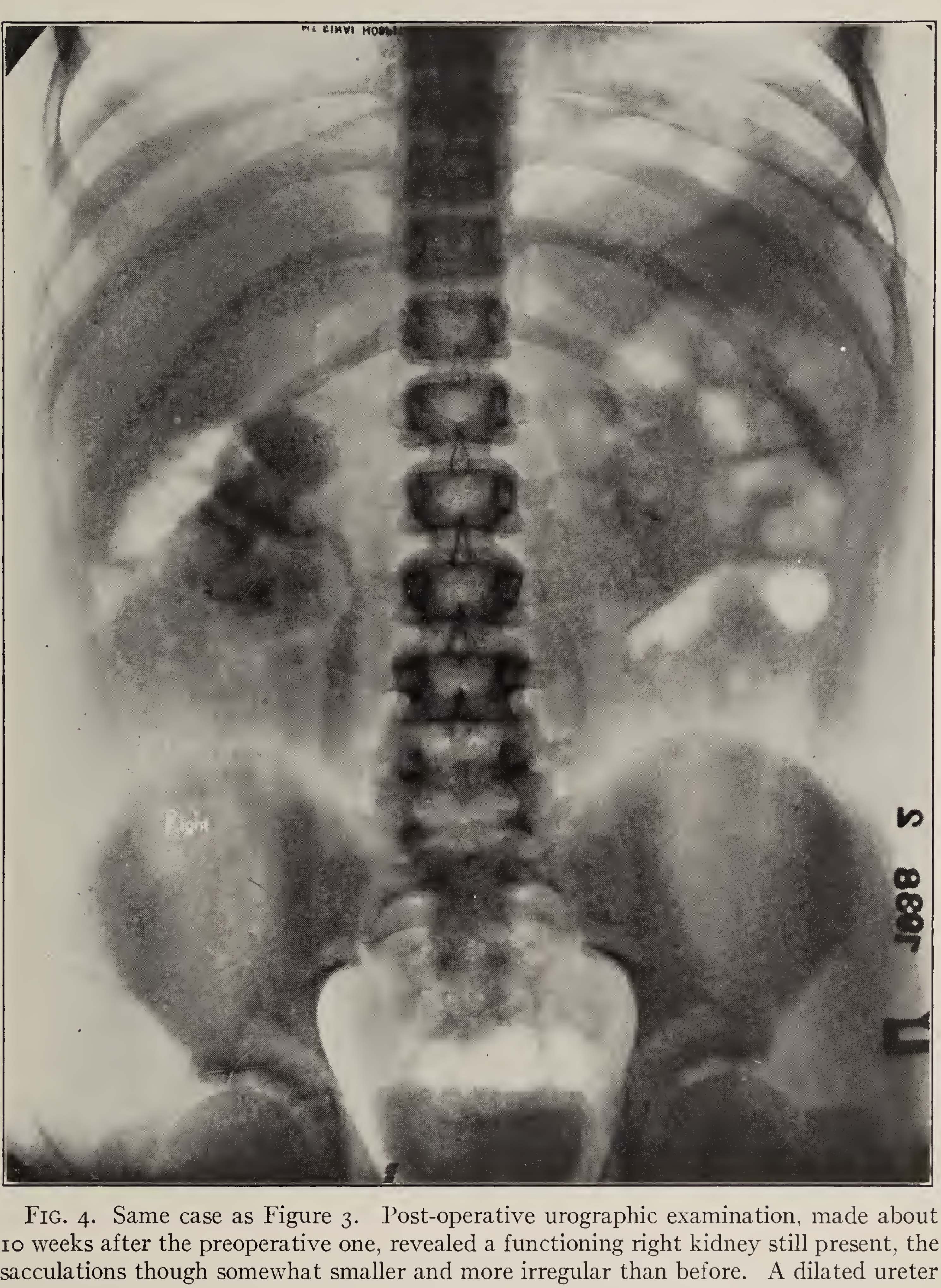

FIG. 4. Same case as Figure 3. Post-operative urographic examination, made about 10 weeks after the preoperative one, revealed a functioning right kidney still present, the sacculations though somewhat smaller and more irregular than before. A dilated ureter is also seen. Despite the presence of good renal function on the right side, as evidenced by the radiologic findings, a secondary nephrectomy had to be performed because of the infection and the clinical course which followed the initial nephrotomy for the calculus.

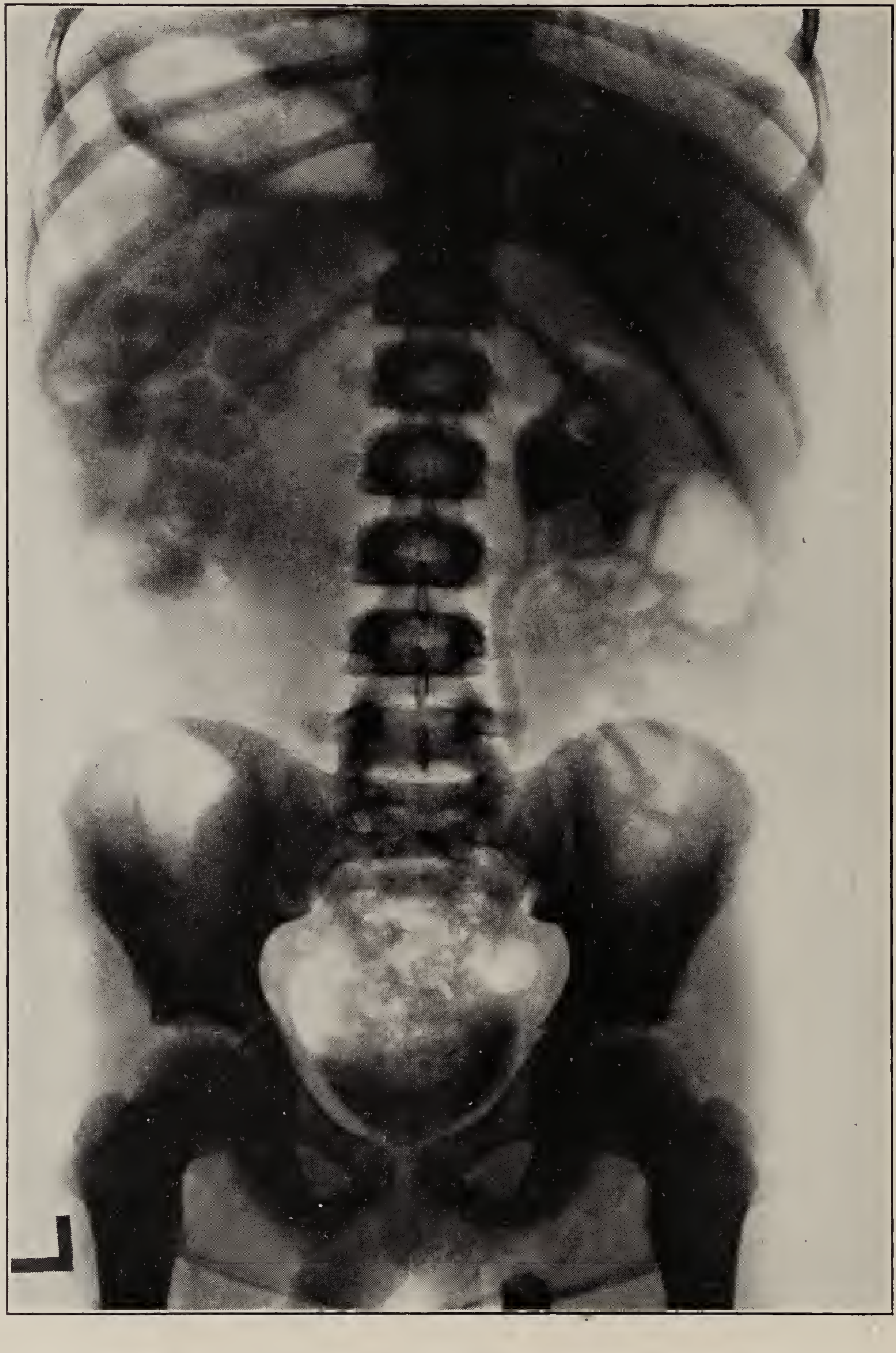

Fig. 5. Intravenous urogram of a boy, aged 12, admitted for pyuria and left loin pain, showing normally appearing and functioning right urinary tract and early filling of several sacculations (dilated calices) of left kidney. (Courtesy of the Journal of the American Medical Association.)

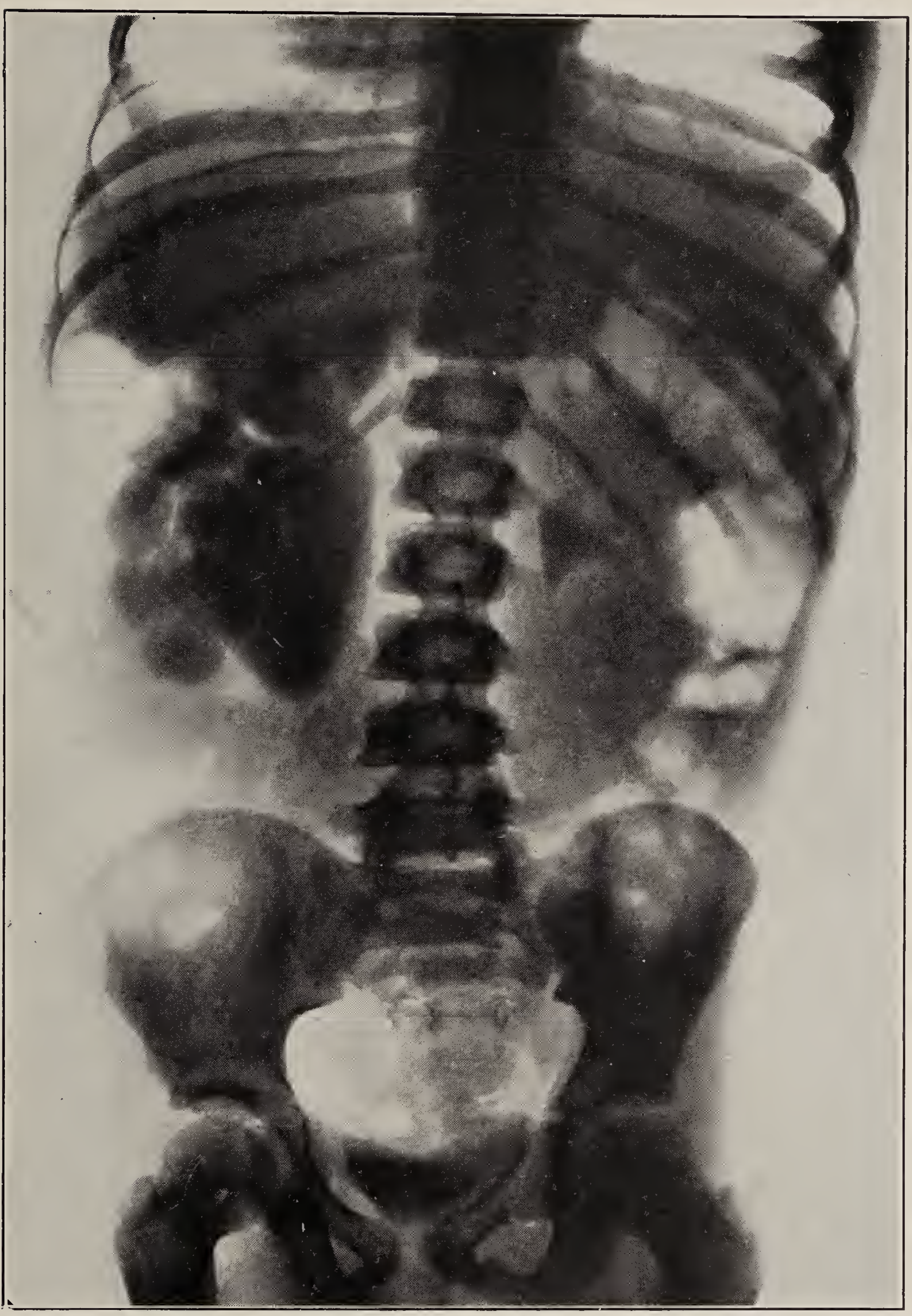

FIG. 6. Same patient as in Figure 5, demonstrating the intense and complete visualization of the left hydronephrotic kidney, obtained several hours after the injection. (Courtesy of the Journal of the American Medical Association.)

IMPORTANCE OF TECHNIC AND KNOWLEDGE OF UROLOGICAL PROBLEMS

In addition to the importance of technic, one's familiarity with urological problems is very essential in the comprehension of the results ob-

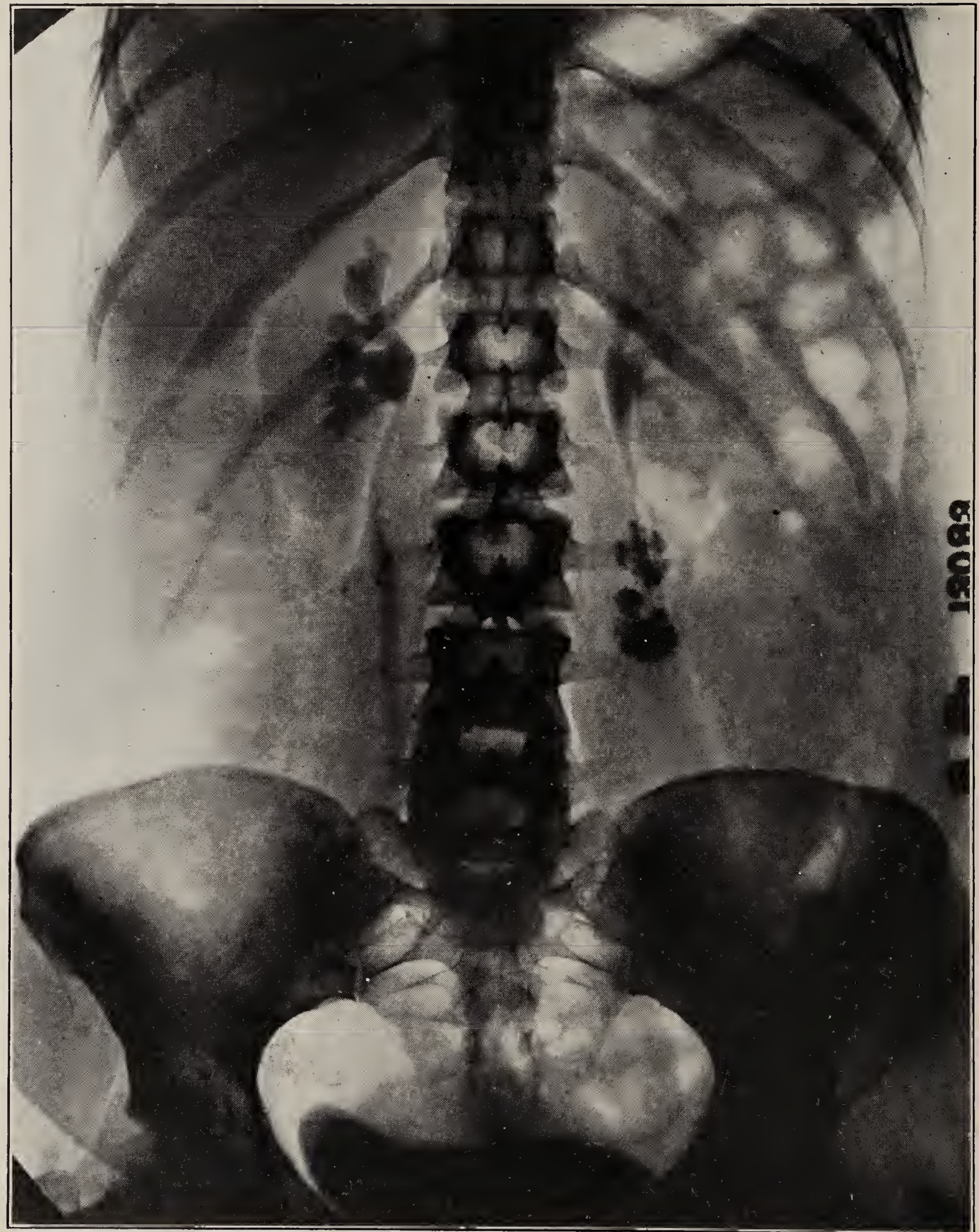

FIG. 7. Intravenous urogram of a woman, aged 24, showing relatively normally appearing and functioning urinary tracts. Admitted for right renal pain. VOL. 3. 732.

tained by excretion urography, lest failures be unduly attributed to it. For example, in cases of ptosis of the kidney with kinking at the uretero-pelvic junction, it is advisable, in testing for retention, that one plate be

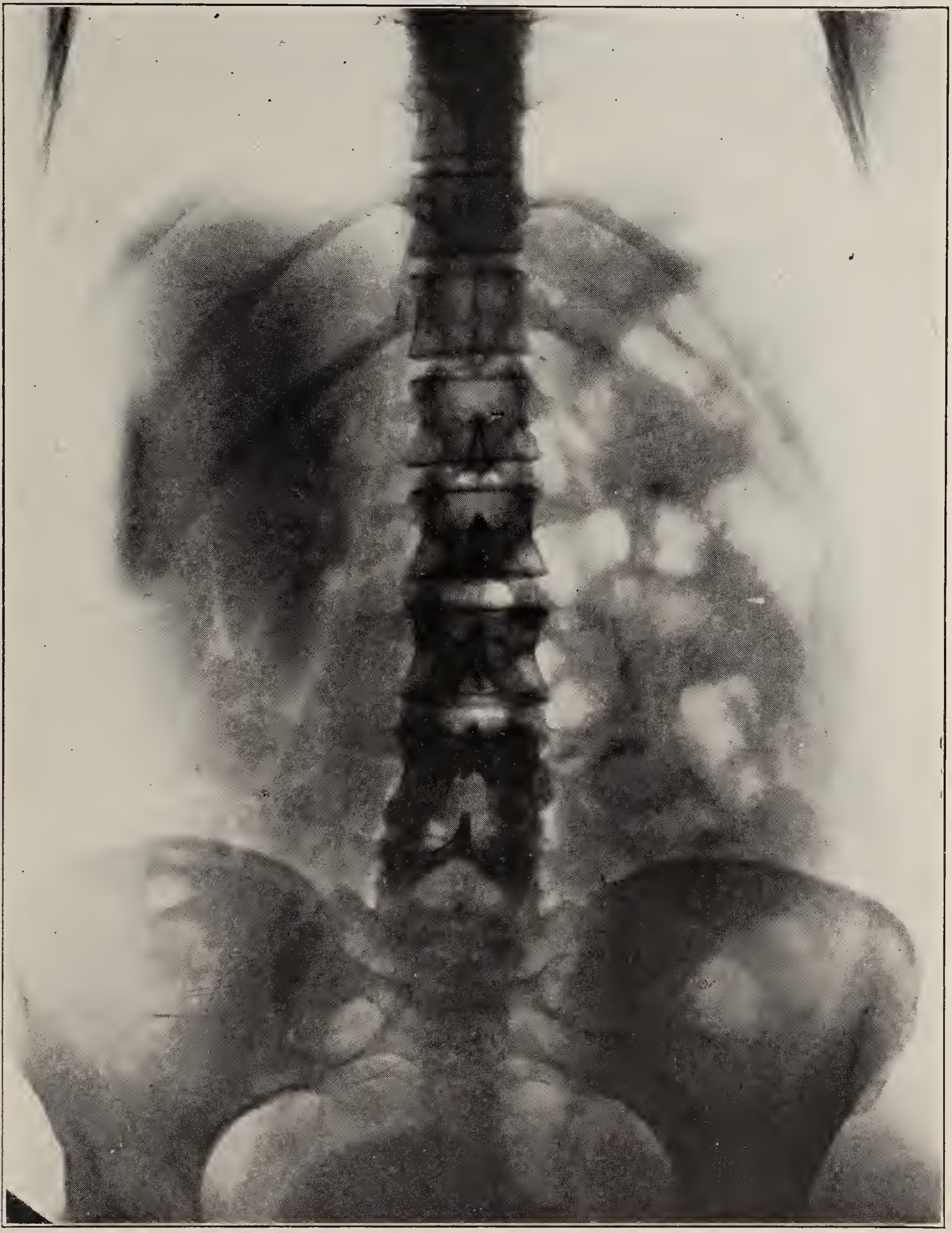

FIG. 8. Same patient as in Figure 7, showing ptosis of right kidney with retention in the kidney pelvis. X-ray exposure in marked reversed Trendelburg position.

taken approximately one and a half hours after the injection (when most of the injected material has normally been excreted) in marked reversed Trendelenburg position maintained for ten minutes without the use of the compression bag.

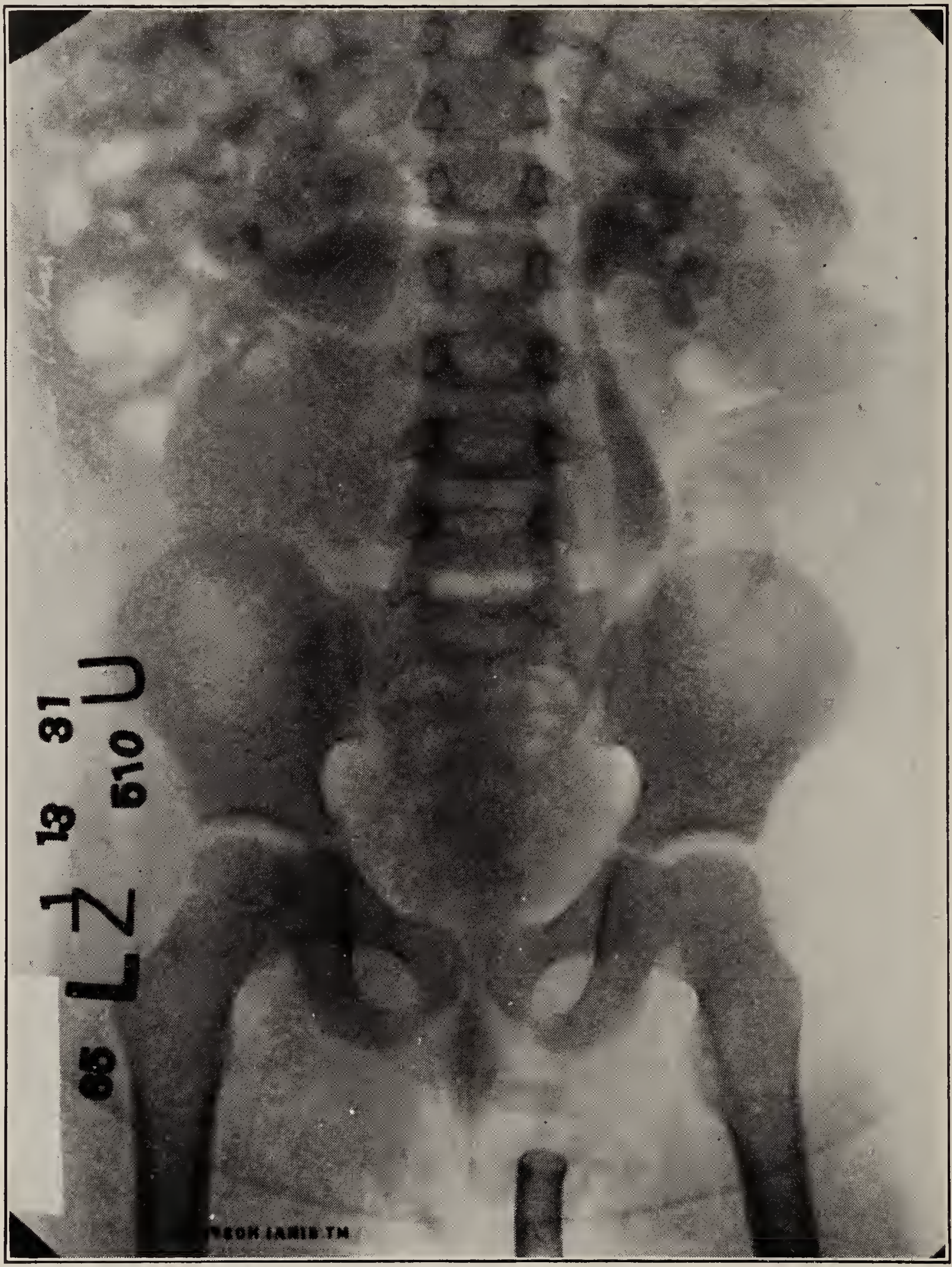

Fig. 9. Intravenous urogram, boy aged 4½, admitted for pyuria. X-ray of abdomen — large mass on left side (thought to be kidney or spleen). Urogram shows dilated left renal pelvis with enlargement and deformity of calices. Left ureter not seen. Right renal pelvis and calices also somewhat enlarged. Right ureter dilated and kinked. Bladder not definitely visualized.

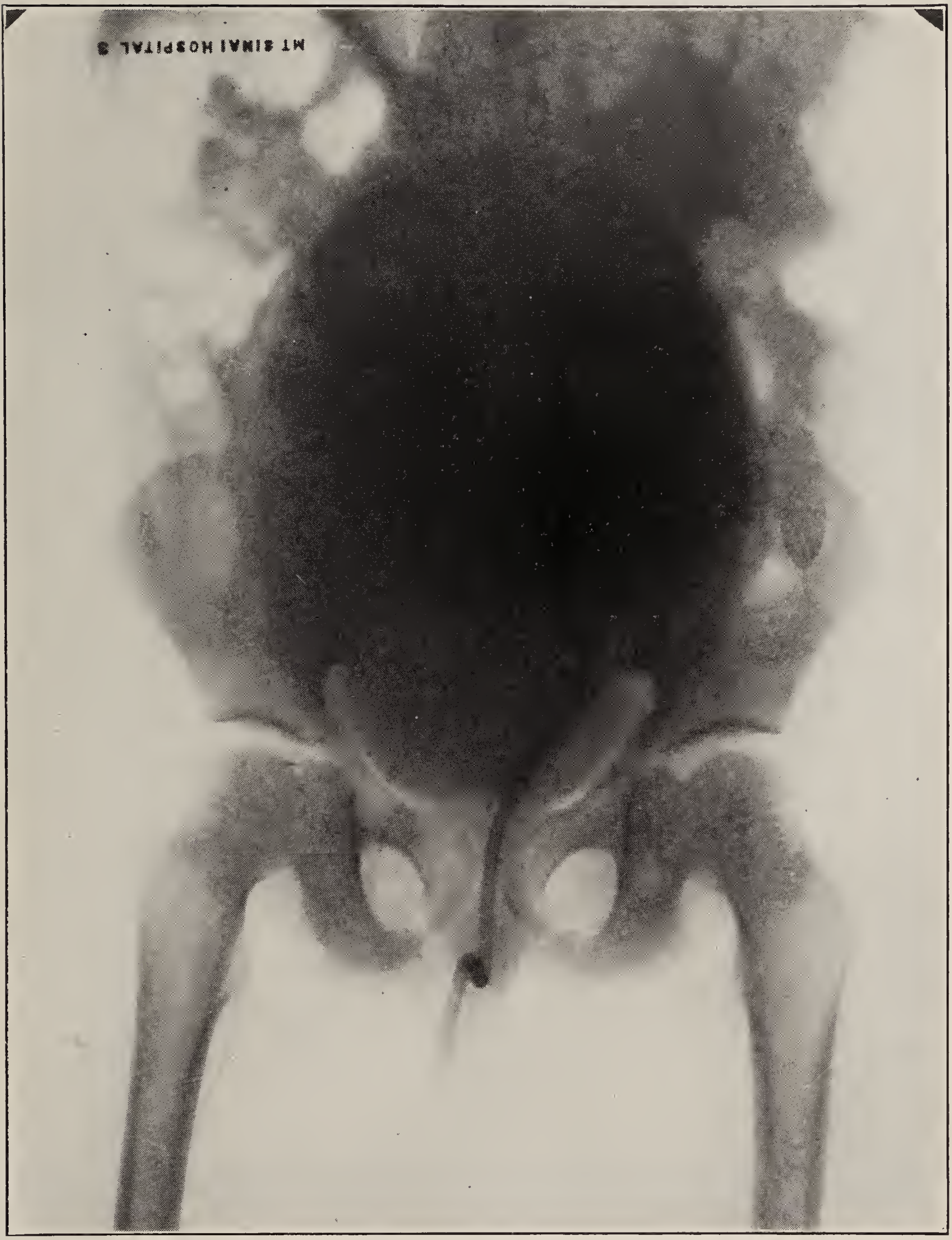

Fig. 10. Same case as Figure 9, demonstrating an enormously distended urinary bladder (containing 600 c.c. of urine) accounting for the mass observed in the x-ray of the abdomen. (X-ray exposure several hours after injection.)

Similarly, in cases of bladder retention due to obstruction at the neck, such as contracture, the patient should be prohibited from voiding for about four hours, in order that an additional film may be secured of the urinary bladder (distended with the excreted radio-opaque urine).

FAILURES

In the majority of cases, good anatomic visualization indicating good renal function is observed. However, instances of poor or no visualization, either bilateral or unilateral, in the face of normal renal function have been encountered. These failures may be of faulty technical origin. For example, a twenty-nine-year-old male patient, with a history of repeated attacks of right renal colic accompanied by hematuria on several occasions, was found by cystoscopy to have an obstruction at about 22 centimeters in the right ureter. At one cystoscopy the obstruction was passed and some retention in the pelvis found. The indigo carmine excretion from the left side was normal; from the right considerably delayed and weak. Excretion urography, on March 17, 1930, was unsatisfactory and the visualization on both sides poor, faint indications here and there being present. There was a rather large amount of intestinal gas. The output of the excreted substance, on the other hand, was found to be normal. A control intravenous urogram, repeated on March 31, 1930, showed at this examination good visualization on both sides, a moderate degree of uretero-hydronephrosis on the right, and a definite shadow of a calculus in the lower end of the right ureter.

Apropos, it is important to mention one case of a unilateral failure to visualize a sacral kidney on two occasions in the presence of normal indigo carmine excretion, in order to point out the need for caution in passing final judgment, in every case, upon the functional state of the kidney by this method alone. The case in question is that of a female patient, aged fifty-four, who complained of pain in the lower back and left kidney region. Intravenous urography showed absence of visualization on the right side on all films. The left urinary tract appeared normal. A large shadow of what looked like kidney was seen in the right upper quadrant. A faint curvilinear shadow in the bony pelvis on the right side was also observed (ureter?). Two days later cystoscopy and a right retrograde pyelogram revealed *normal indigo carmine excretion* from both sides as well as the *presence of a right sacral kidney*. In order to investigate further this discrepancy, the intravenous urographic examination was repeated two and a half weeks later. The right kidney pelvis again was not visualized, though the ureter could definitely be seen at this sitting.

TEMPORARY FUNCTIONAL INHIBITION

Moreover, it is important to bear in mind that the functional activity of the kidney may be temporarily inhibited and that the mere non-visualization at a given examination does not necessarily signify permanent renal damage. The following cases are illustrative:

A forty-one-year-old male patient was cystoscoped and a left retrograde pyelogram made. At that examination normal indigo carmine excretion from both ureteral orifices was seen. The pyelogram was normal. Following the instrumentation, hematuria and marked pain in the left loin set in and persisted for about one week. When both symptoms had subsided, intravenous urography was done. Absence of visualization of the pelvis and ureter with good kidney outline on the previously pyelogrammed and apparently traumatized left side, in addition to a double pelvis and forked ureter on the right, were noted. However, another intravenous urographic examination, about three months later, revealed a normally functioning and appearing left urinary tract plus the previous findings on the right — a case of temporary functional inhibition following retrograde pyelography.

Figures 13 and 14 again serve to point out this principle. This patient entered the hospital for left renal colic. Cystoscopy revealed an obstruction at 25 centimeters, no flow, and no indigo carmine excretion from the left side. The right was normal. X-ray examination of the urinary tract showed several small areas of calcification within the left renal shadow and one at the left uretero-pelvic junction. Excretion urography, on July 16, 1930, revealed *absence of visualization* on the left side and normal findings on the right. On July 17, 1930, a left pyelolithotomy was done and one stone in the region of the uretero-pelvic junction removed. On August 4, 1930, a second post-operative intravenous urogram showed *delayed but distinct* visualization of a dilated pelvis and calices of the left operated side besides the findings on the normal side — another case of temporary functional inhibition secondary to a high occluding ureteral stone.

Therefore, to evaluate excretion urography, it is of paramount importance to consider this method one of excretion and to bear constantly in mind the processes occurring in the renal and extrarenal systems.

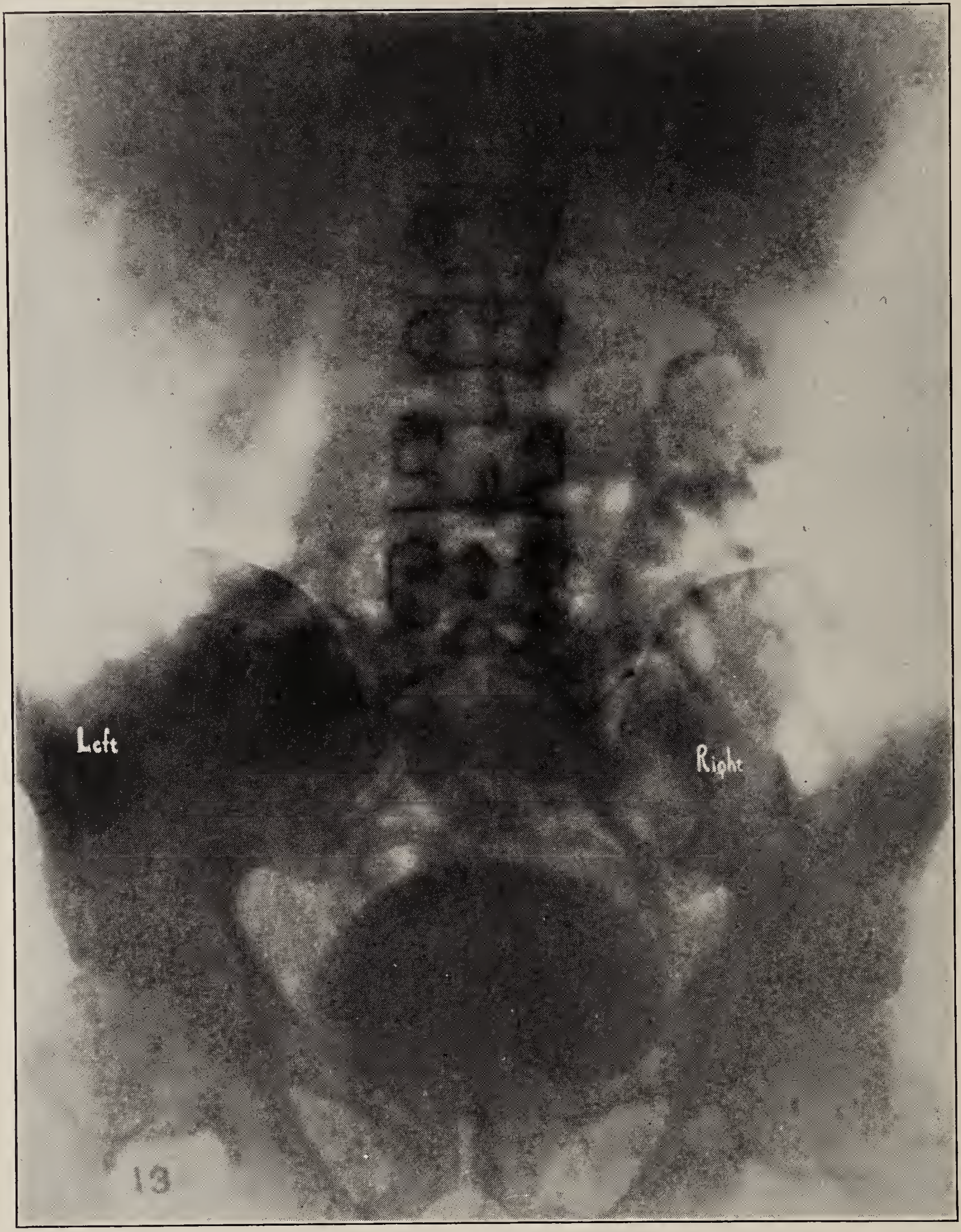

FIG. 11. Intravenous urogram, 41-year-old male patient, showing absence of visualization of the pelvis and ureter with good kidney outline on the previously pyelogrammed and apparently traumatized left side, in addition to a double pelvis and forked ureter on the right. By cystoscopic examination it was known previously that the indigo carmine excretion was normal from both sides. It is interesting to note that this urographic examination was carried out about one week after the cystoscopy and the left retrograde pyelogram had been performed. This case illustrates temporary functional inhibition following retrograde pyelography. VOL. 3. 732.

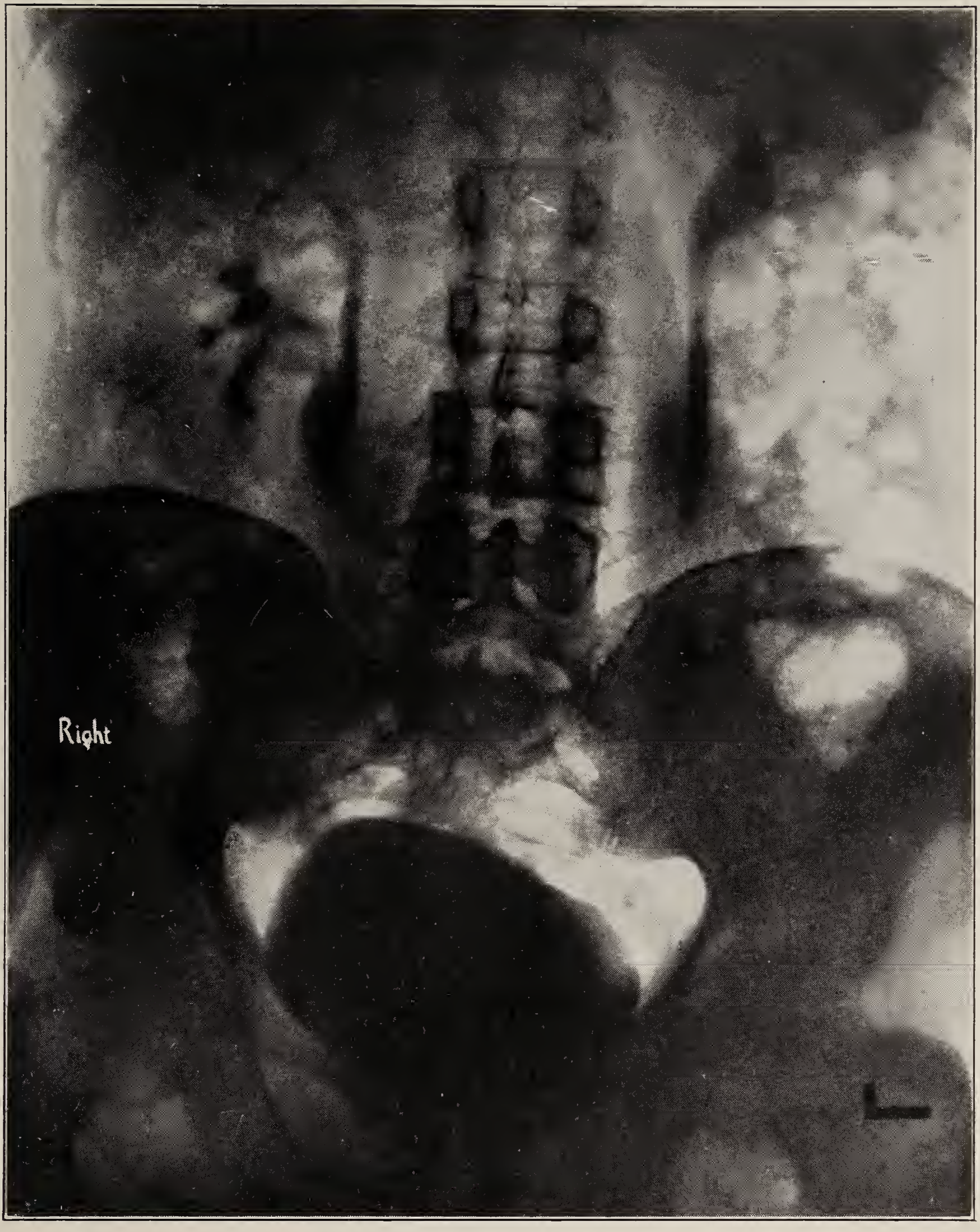

FIG. 12. Same case as Figure 11. A subsequent intravenous urographic examination about 3 months later shows the return of function of the left kidney, demonstrating also a normal left urinary tract plus the previous findings on the right. (Courtesy of the American Medical Association.)

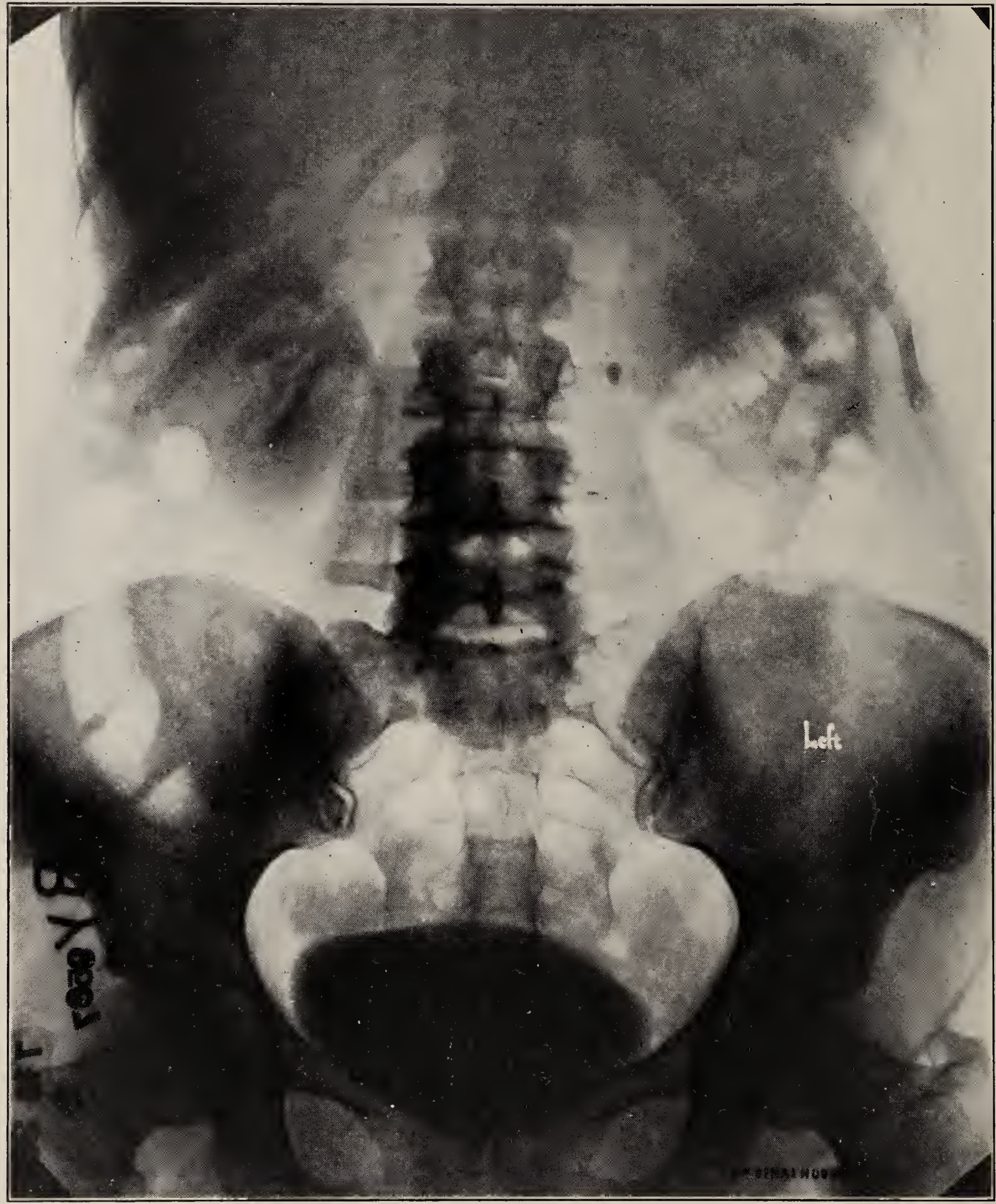

Fig. 13. Intravenous urogram of another case revealing the absence of visualization on the left side incidental to a high occluding stone at the uretero-pelvic junction. The right urinary tract is normal.

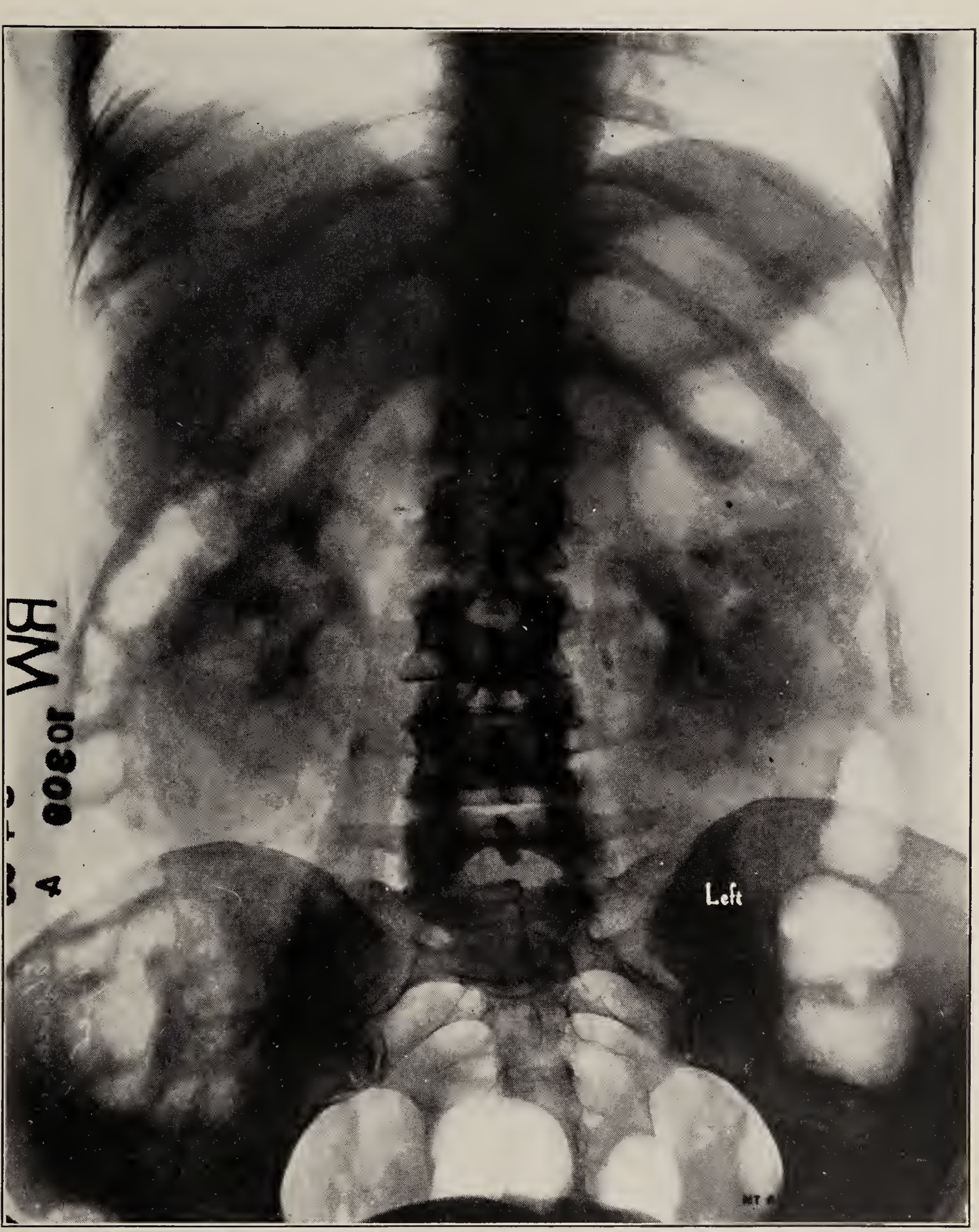

FIG. 14. Same case as Figure 13. The post-operative intravenous urogram, 2½ weeks after a left pyelolithotomy for the removal of the above stone, shows the return of function of the left kidney as evidenced by the delayed, somewhat fainter but distinct visualization of a dilated pelvis and calices. This case again demonstrates temporary functional inhibition, this time secondary to a high occluding ureteral stone.

METHOD OF ADMINISTRATION

For an adult, the usual dose — 40 grams of substance — is dissolved in previously warmed, doubly distilled water, so that the resultant volume is 100 cubic centimeters. The solution is filtered twice and sterilized. The intravenous administration is carried out over a period of about ten minutes. The first roentgenogram is taken fifteen to twenty minutes after the injection and three subsequent exposures about twenty-five minutes apart. Where functional disturbances are present, additional later films at approximately one to three-hour intervals are made to determine definitely the absence of visualization or the presence of late visualization. To illustrate: one case in particular, that of a ureteral stone obstruction, failed to show definite visualization until twelve hours after the injection. (A 20-gram dose in adults has also yielded positive results.)

The dosage (40 per cent. concentration) for children is as follows:

From 9–13 years of age	25 grams of substance.
6 years of age	20 grams of substance.
2–4 years of age	15 grams of substance.
6 months of age......	10 grams of substance.

The dosage of the newly introduced preparations mentioned previously, which have displaced Uroselectan, is administered in accordance with the directions advocated by the respective workers.

IMPORTANCE OF APPLICATION OF COMPRESSION

An added factor of great importance, which has aided materially in improving the results, has been the application of a moderate degree of compression by means of an air-inflated rubber balloon (basket-ball bladder), maintained over the urinary bladder region for from five to ten minutes prior to and during the taking of each roentgenogram. The use of compression is essential in obtaining readable and suitably diagnostic x-ray pictures. Without its application, incomplete, indistinct, and faint shadows are often obtained which may lead to an erroneous assumption that one is dealing with a filling-defect of a calix or pelvis caused by the pressure of a kidney tumor or renal tuberculosis, et cetera. This consideration is obviously a vital one, aside from the fact that poorly diagnostic radiograms are observed. It also appears very likely that the various unsatisfactory experiences with and results of excretion urography, as reported by different individuals, are due to the failure to utilize this simple but invaluable aid. On the other hand, where compression is applied the results are quite the reverse: the shadows are sharply demar-

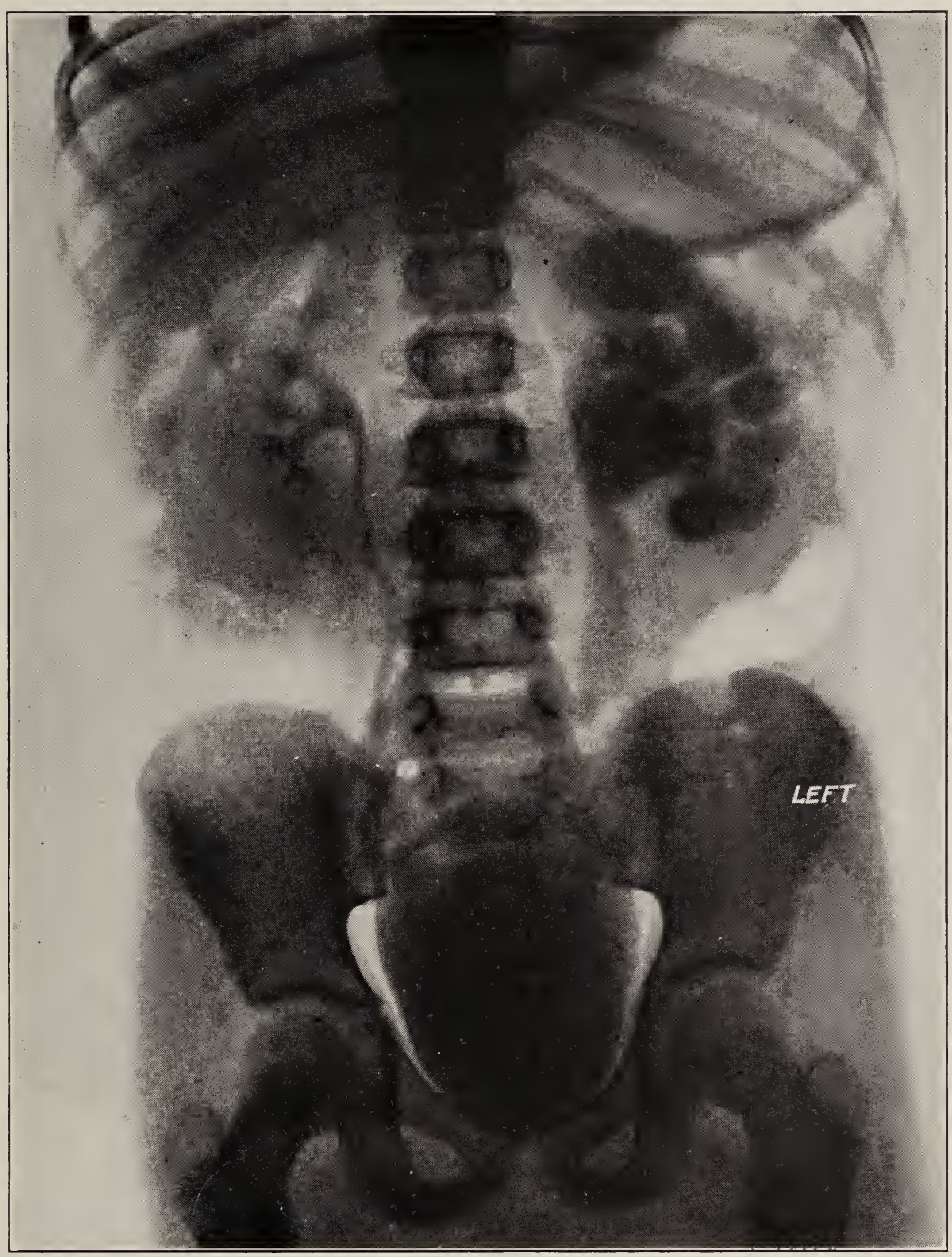

FIG. 15. Marked dilatation of left ureter, kidney pelvis and calices in a boy, aged 10, admitted for hematuria. Right urinary tract normal appearing, despite application of compression in midline. (Case of Drs. Leopold and Stewart of the Lenox Hill Hospital, New York. Courtesy of the Journal of the American Medical Association.)

cated, well defined, and distinct. Intestinal gas is usually displaced laterad and the structures are held relatively fixed in position during the x-ray exposure.

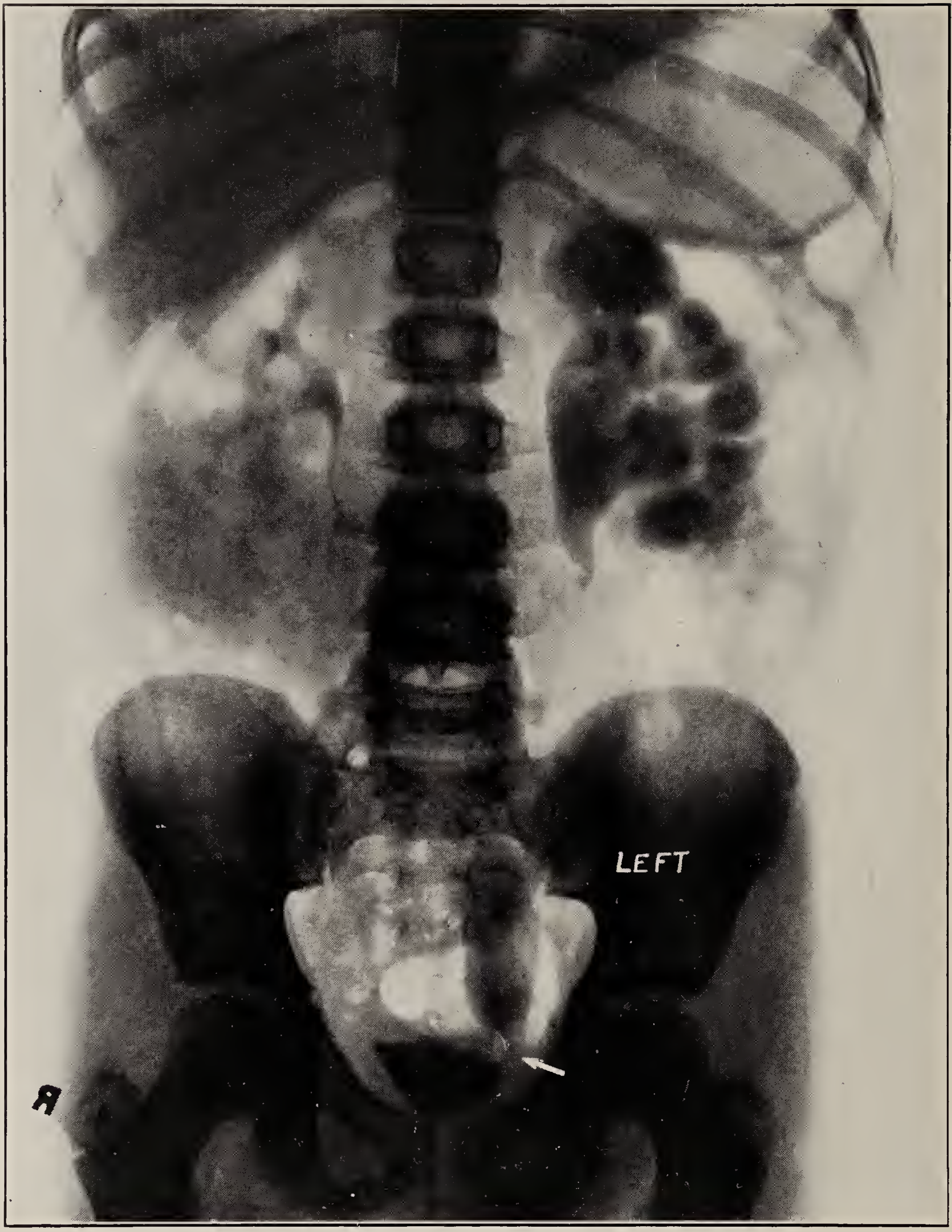

Fig. 16. Same patient as in Figure 15, with bladder partially empty, now demonstrating stricture (congenital) uretero-vesical junction with marked dilatation of lower part of ureter, which was hidden on previous film by distended bladder. (Courtesy of the Journal of the American Medical Association.)

The objection raised, that the use of compression produces an artificial dilatation of the urinary tract, does not appear to be the case. Where the normal tone of the pelvis and ureter is present, normal contours are observed; where atony or dilatation of the conducting system is present, this condition is visualized. Figures 15 and 16, where compression was applied in the midline over the urinary bladder region, reveal the normal structures on the right but a uretero-hydronephrosis on the left, conditioned by a congenital stricture at the uretero-vesical junction; in other words, compression could not produce an artificial dilatation on the right side so long as the normal tonic state prevailed. Furthermore, one does not create a complete obstruction with the use of the compression bag, since a bladder filling is observed despite its application prior to the administration of the drug. An additional film without compression, before or after any of the preceding ones, may also be taken.

FIELD OF APPLICATION AND USEFULNESS

The field of application of excretion urography is evident wherever cystoscopy, ureteral catheterization, or retrograde pyelography is dangerous or impossible in the presence of infection or for mechanical reasons, and whenever these procedures in general are indicated. Aside from offering a bilateral urogram, the procedure is very helpful in the presence of hematuria, in cases of reimplanted ureter, in cases of anomalies, in children, and in individuals in whom instrumentation is taxing and harmful. As an example: in one case of profuse hematuria, because of the *non-visualization* of the conducting system on one side in the presence of a normally appearing and functioning contralateral urinary tract, the only means at arriving at the localization of the causative factor, a tumor of the kidney, was solely by this method. Excretion urography is particularly applicable in cases presenting obscure abdominal symptoms and conditions, the so-called borderline cases, in which one is adverse or hesitates to subject a patient to the retrograde route of investigation. The differentiation of abdominal masses, whether of intra- or extra-urinary origin, has been frequently facilitated by this method of approach.

Cases of hydronephrosis, as well as the presence of congenital anomalies, have been detected where least suspected. Children, in whom pyuria has been usually attributed to simple pyelitis or pyelonephritis, have been found to be suffering from infected hydronephroses, congenital anomalies, tuberculosis, calculus, or, as in one case, urinary retention due to contracture at the neck of the bladder. Pain of obscure origin, particularly in the right kidney region, has been observed with the aid of excretion urography to be associated in some instances with ptosis of the kidney, kinking at the uretero-pelvic junction, and concomitant retention in the kidney pelvis, either dilated or infected.

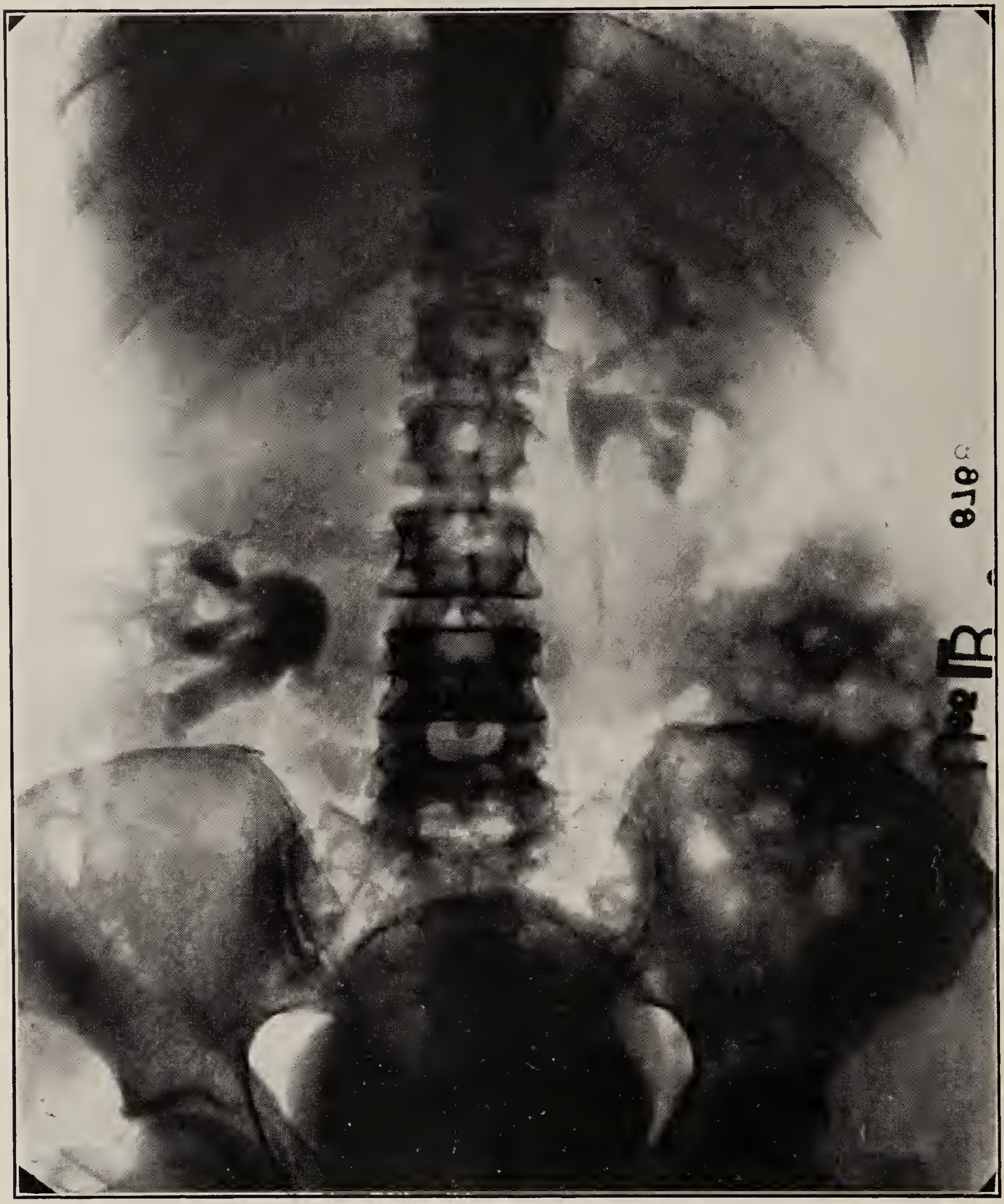

Fig. 17. Intravenous urogram, woman aged 50, admitted for right abdominal pain with radiation to hip, right lumbar region, sacrum, and lower chest, weakness, dyspnœa and nausea. Large mass palpable in r.u.q. considered right lobe of liver. Shows right kidney markedly displaced downwards by an extra-renal mass — pelvis and calices, except for slight dilatation of lower one, normal. Right ureter tortuous. Left urinary tract normal. Operative findings — carcinoma of right adrenal gland (cortex).

NON-VISUALIZATION AS AN AID IN LOCALIZATION AND DIAGNOSIS

It has been the opinion of some observers that in cases of renal tuberculosis excretion urography has been of little or no diagnostic value. This has not proven to be our experience. It should be borne in mind that even the mere non-visualization of a conducting system, incidental to the functional-anatomic derangement of the kidney parenchyma, is in itself of great assistance as a means of localization and of diagnosis when considered together with the other clinical data. Cases of calculus pyonephrosis, tuberculous pyonephrosis, and tumors of the kidney have been so diagnosed when viewed clinically in their entirety. In addition, one gains an insight into the functional and anatomic status of the contralateral side, essential in the evaluation of the individual as an operative risk.

The following illustrations exemplify the results obtained in some of the different urological conditions:

(*a*) Normal — Figure 18.
(*b*) Anomalies — Figure 19.
(*c*) Urinary infections — Figures 20 and 21.
(*d*) Renal tuberculosis — Figures 22, 23 and 24.
(*e*) Calculus — Figures 25 and 26.
(*f*) Renal tumor — Figure 27.
(*g*) Bladder conditions — Figures 28 and 29.
(*h*) Obscure abdominal conditions — Figure 30.

CONTRAINDICATIONS

Patients with uremia or latent uremia, as determined by the usual clinical methods, do not lend themselves to the application of this procedure. It is therefore wise to precede the examination by a determination of the blood urea, phenolsulphonephthalein, indigo carmine, or the dilution and concentration tests. Where the blood urea is high and the concentrating power of the kidney poor, the method yields few anatomic data and becomes not only superfluous but may, perhaps, be attended with danger. For information of renal function under such circumstances, more simple and less expensive means, such as the blood urea and phenolsulphonephthalein determinations, serve the purpose.

In summarizing, it might be considered indicated to suggest caution, reserve, and a careful scientific approach in dealing with this relatively new field of investigation. Retrograde pyelography will be found necessary in corroborating or supplementing where the results of excretion urography are equivocal; and, vice versa, the latter will be useful where the former is in general applicable, or where, for mechanical reasons or in the presence of severe infection, retrograde pyelography cannot be carried out or is contraindicated.*

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* The author wishes to express his thanks to the Journal of the American Medical Association and to the American Journal of Surgery for the courtesy of permitting him to utilize illustrations and material from his previous publications in those journals.

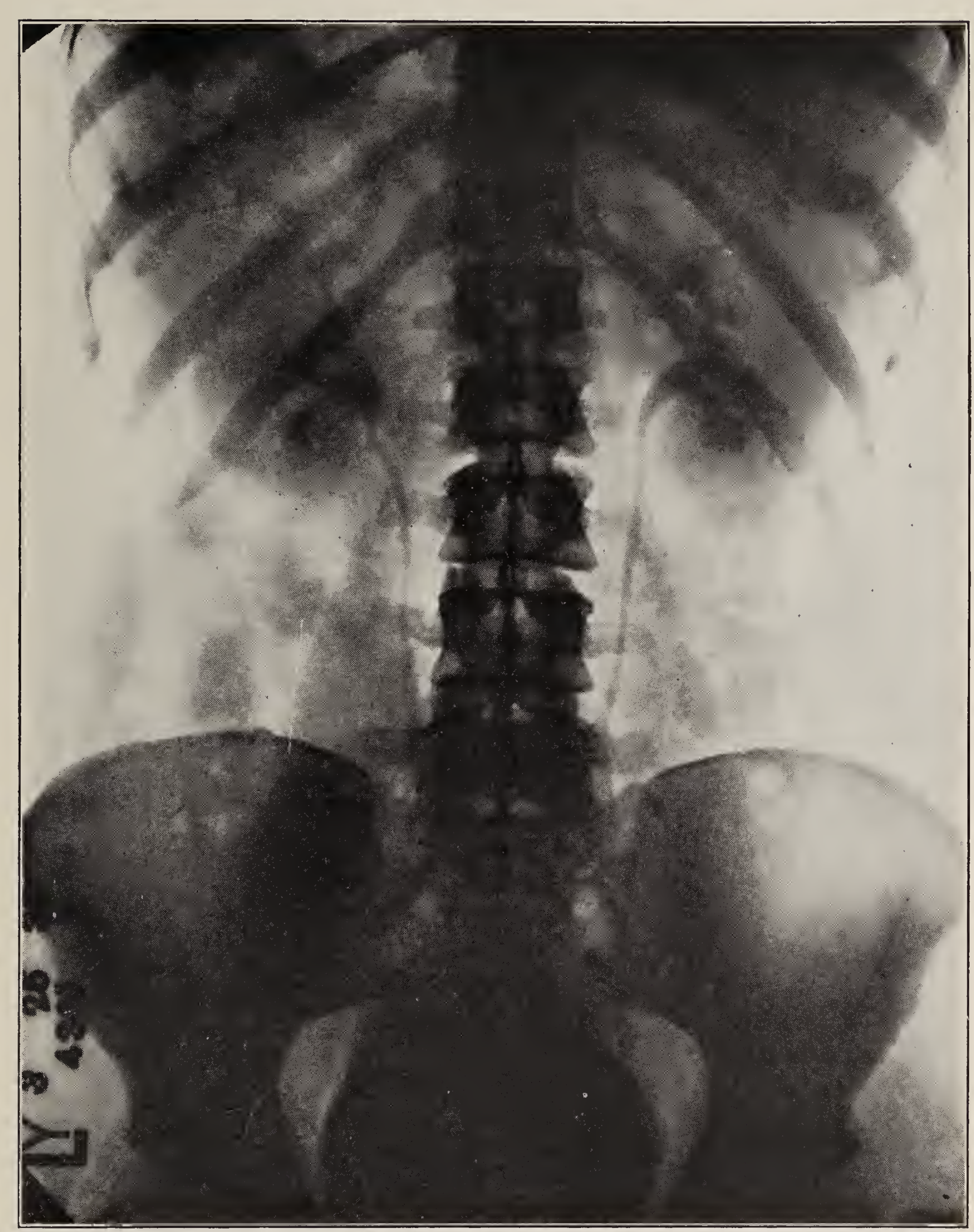

FIG. 18. Intravenous urogram, woman aged 36. Demonstrates normally appearing and functioning urinary tracts. (Courtesy of the Journal of the American Medical Association.)

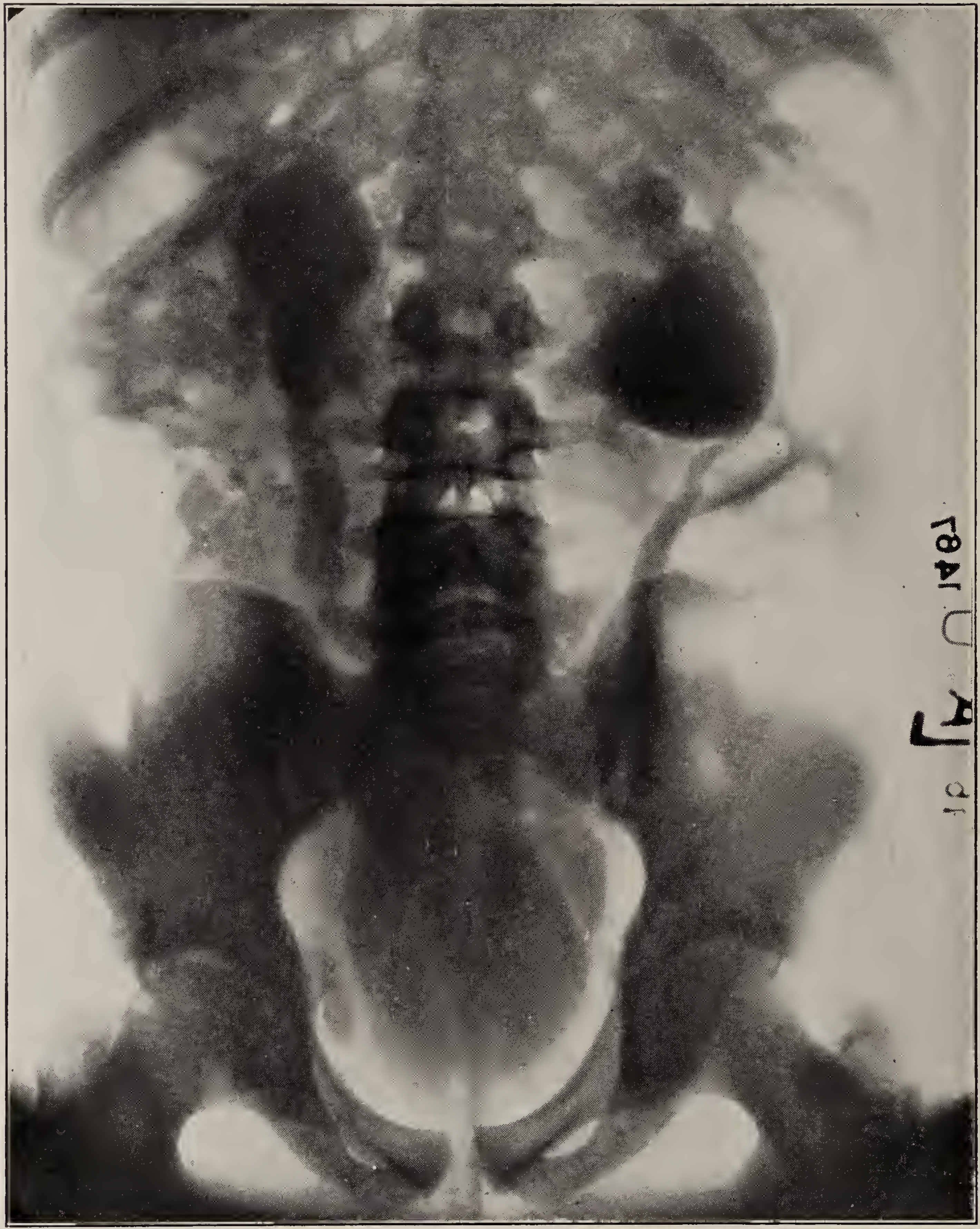

Fig. 19. Intravenous urogram, boy aged 11, admitted for dysuria, pyuria, right loin pain and fever. Reveals findings of horse-shoe kidney with bilateral dilatation of pelves, calices and ureters (ureteropyelonephritis), and diverticula of the bladder.

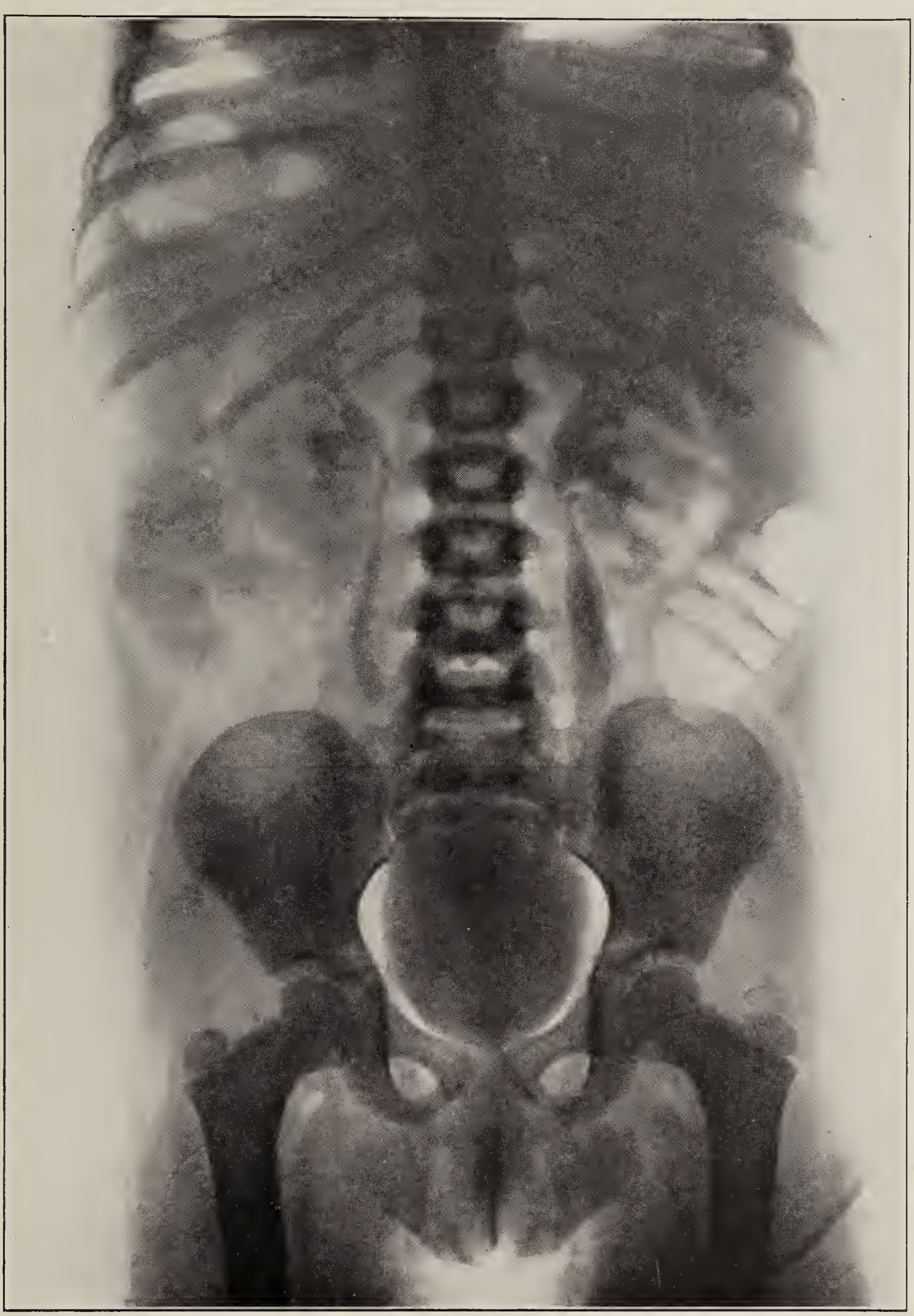

Fig. 20. Intravenous urogram, girl aged 5½. Shows bilateral pyeloureteritis, more marked on right side. Twist of right ureter below uretero-pelvic junction. (Courtesy of the Journal of American Medical Association and American Journal of Surgery.)

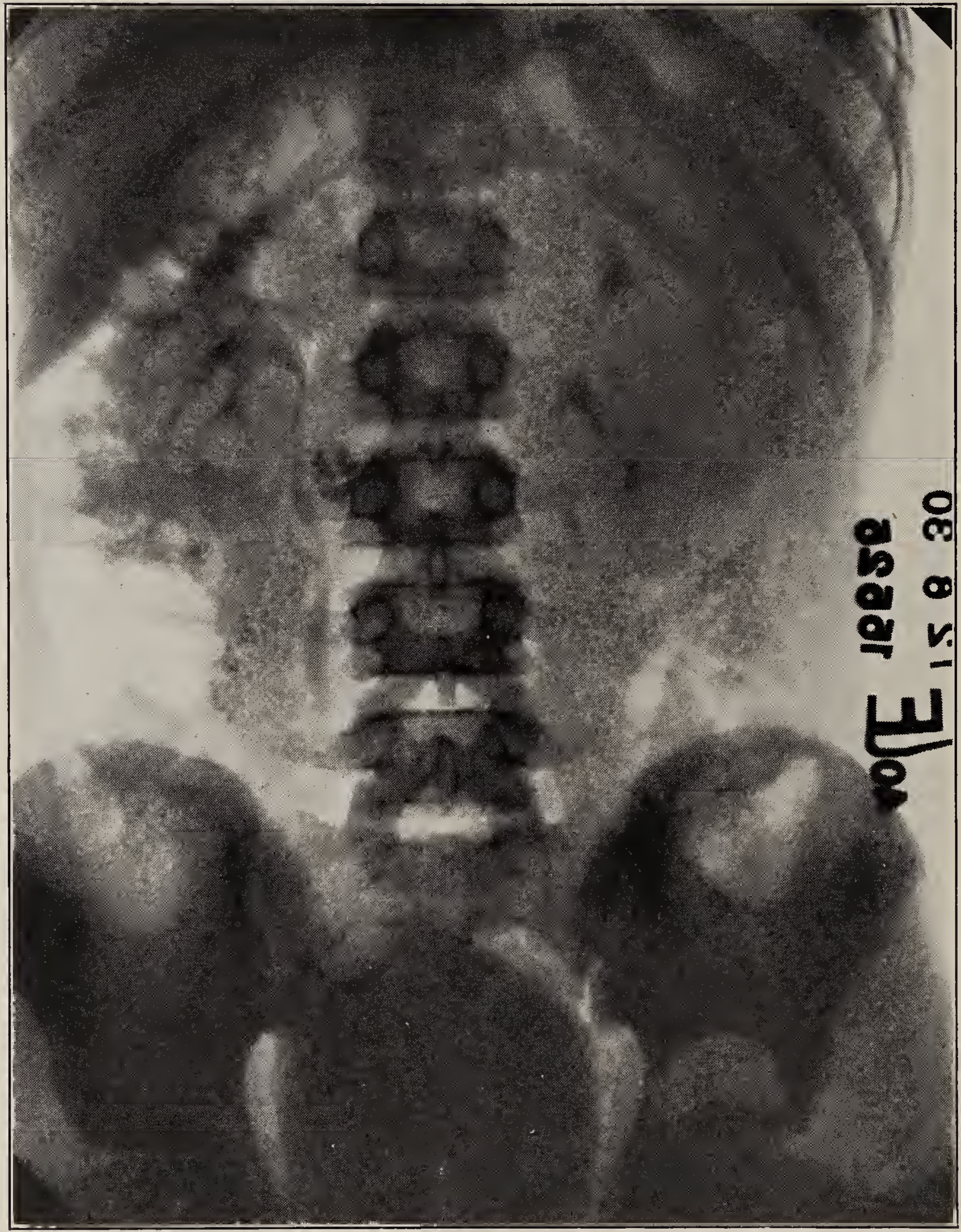

Fig. 21. Intravenous urogram, boy aged 13½, admitted for left lumbar pain, tender left kidney; urine negative. Shows compression of pelvis and middle calix, and contraction of neck of upper calix on the left side — appearance that of a mass compressing pelvis and calices. Right side normal. Diagnosis and operative findings — chronic carbuncle of left kidney.

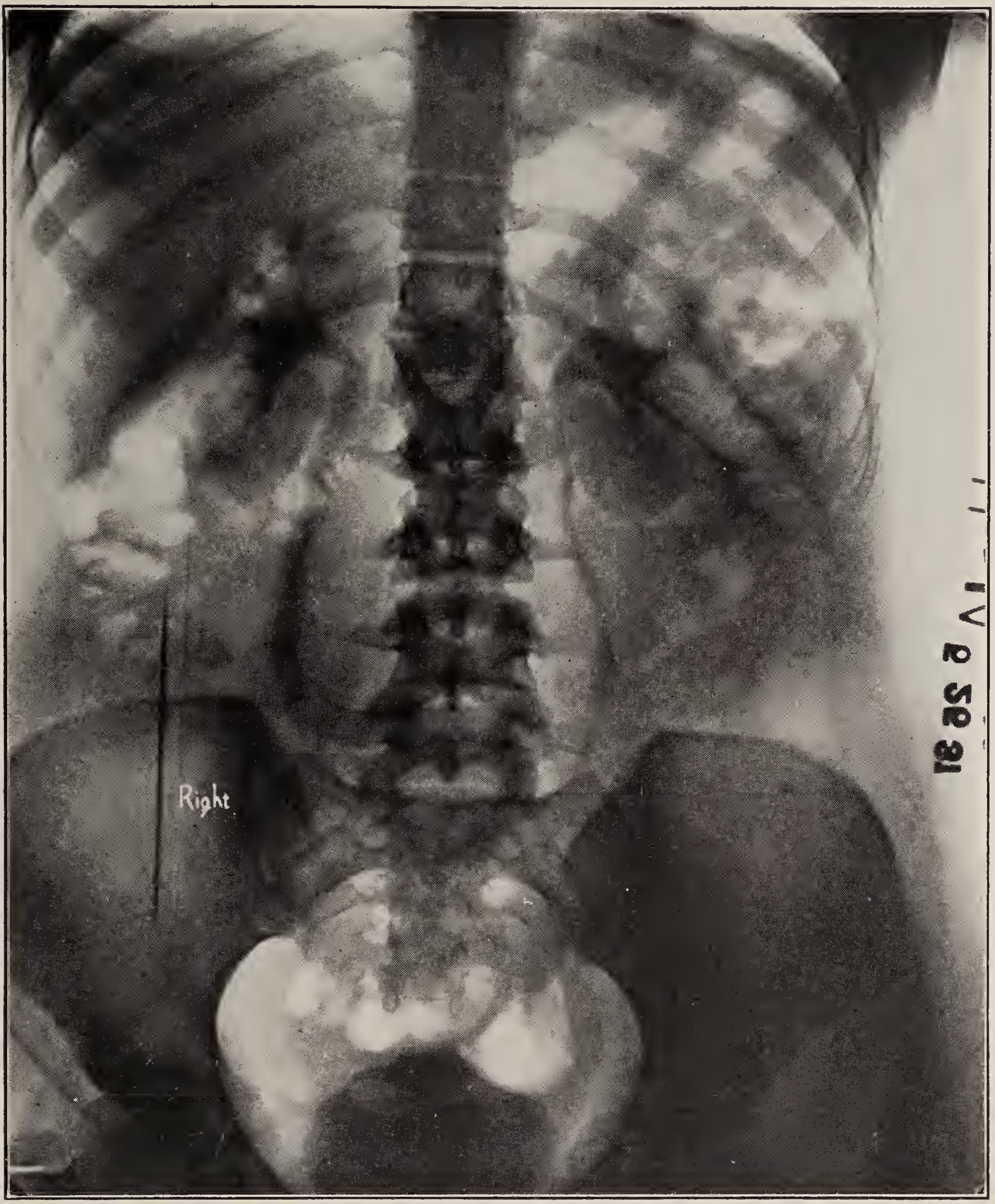

FIG. 22. Intravenous urogram, girl aged 17½. (Pott's disease of first lumbar vertebra.) Shows normal left side. Right upper calix appears irregular and moth-eaten, ureter dilated for its entire distance. Diagnosis — renal tuberculosis (right).

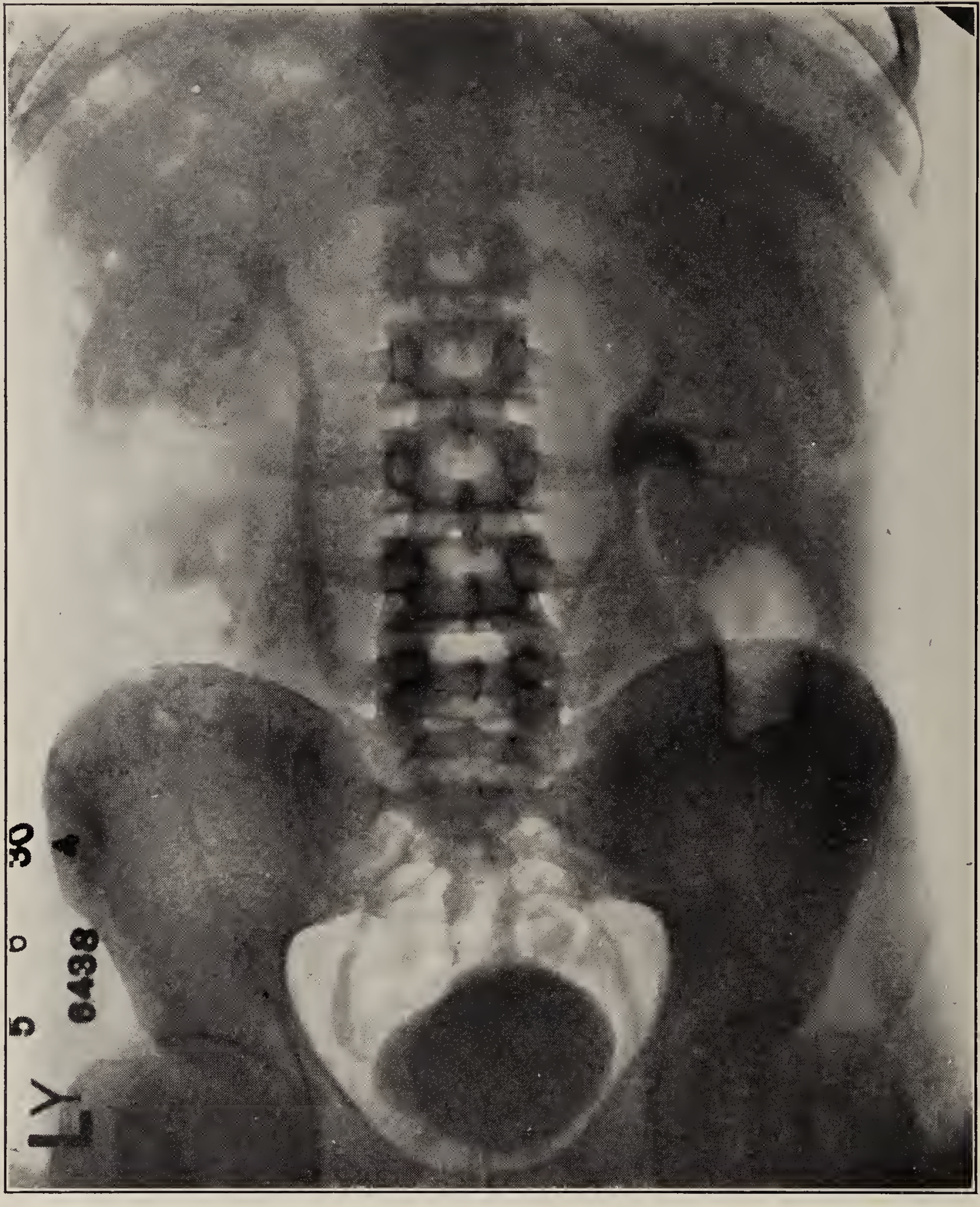

Fig. 23. Intravenous urogram, man aged 32. Left kidney shows a circularly outlined cavity containing deposits of calcium in region of middle calix (closed-off tuberculous cavity of middle calix). Left ureter straight and rigid-appearing, terminal 2 inches irregular. Right urinary tract, save for nephroptosis, normal. (Courtesy of the Journal of the American Medical Association.)

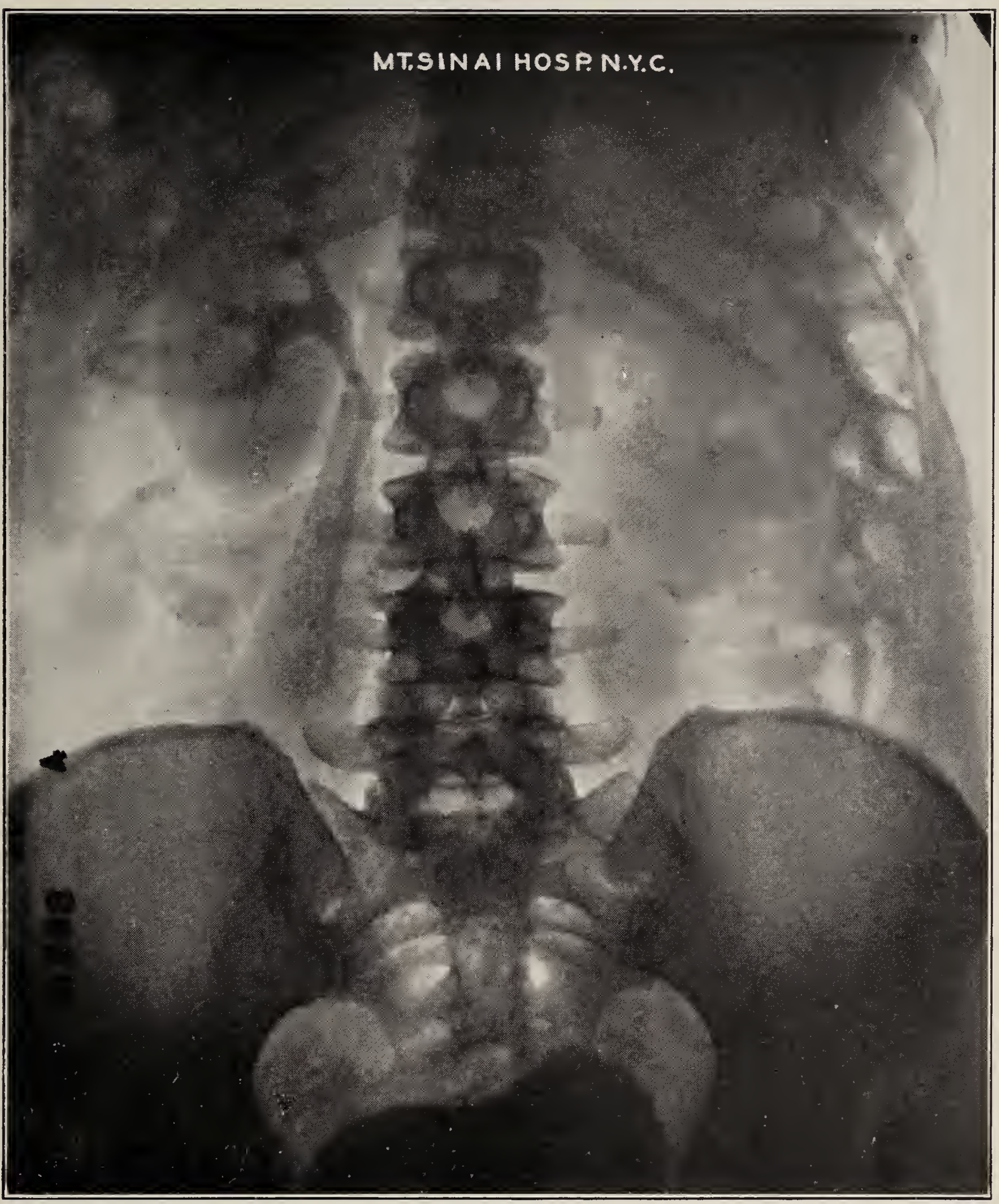

FIG. 24. Intravenous urogram of a woman, aged 45, showing non-functioning sacculated right kidney, proved at operation to be a tuberculous pyonephrosis. Retrograde pyelogram impossible. Ureter could not be entered. Left side normal. (Courtesy of the Journal of the American Medical Association.)

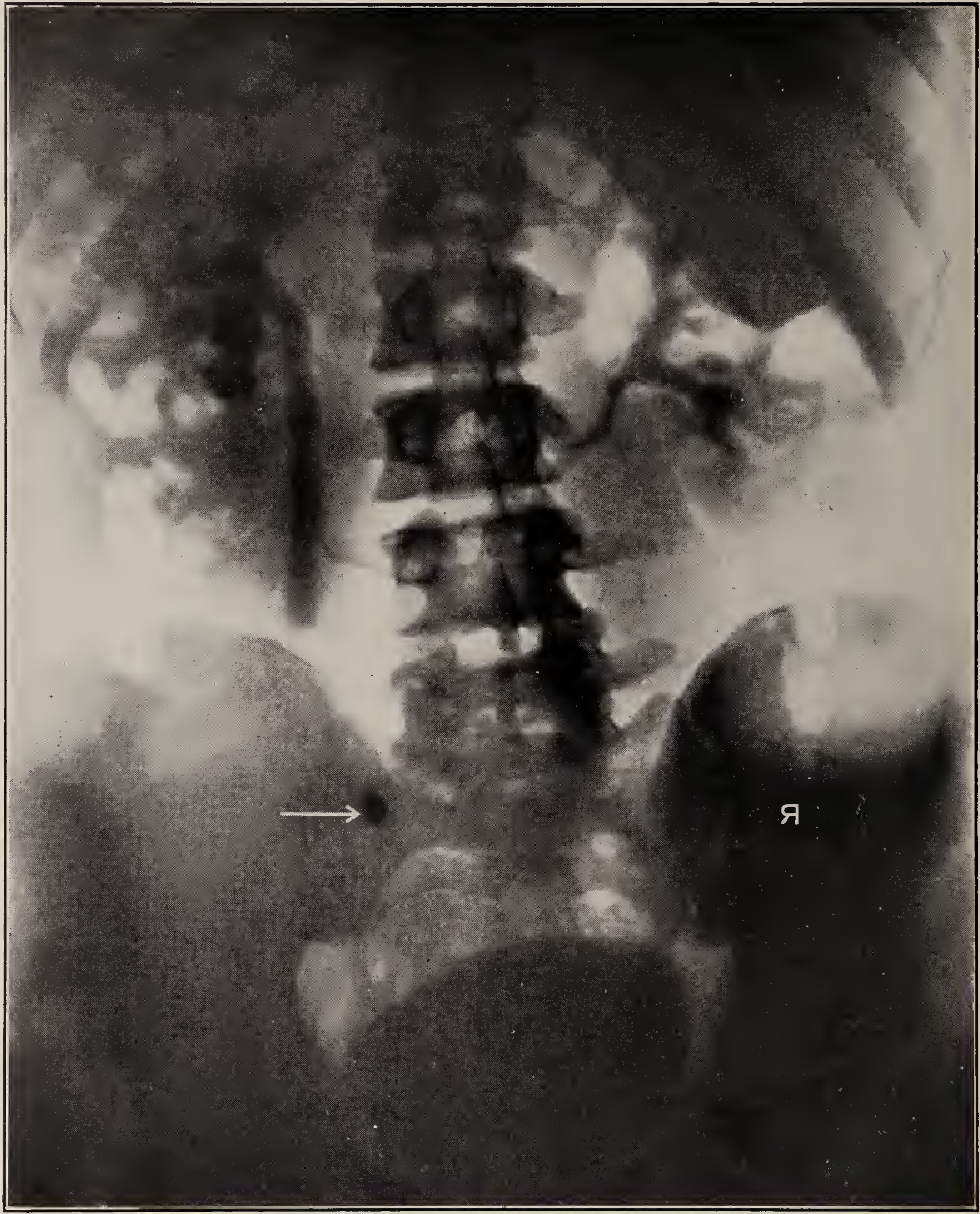

Fig. 25. Impassable stone obstruction, lower third of the left ureter, in a boy aged 19. Intravenous urogram shows good function and dilated ureter, pelvis, and calices above stone. Right side normal. Arrow points to stone. (Courtesy of the Journal of the American Medical Association.)

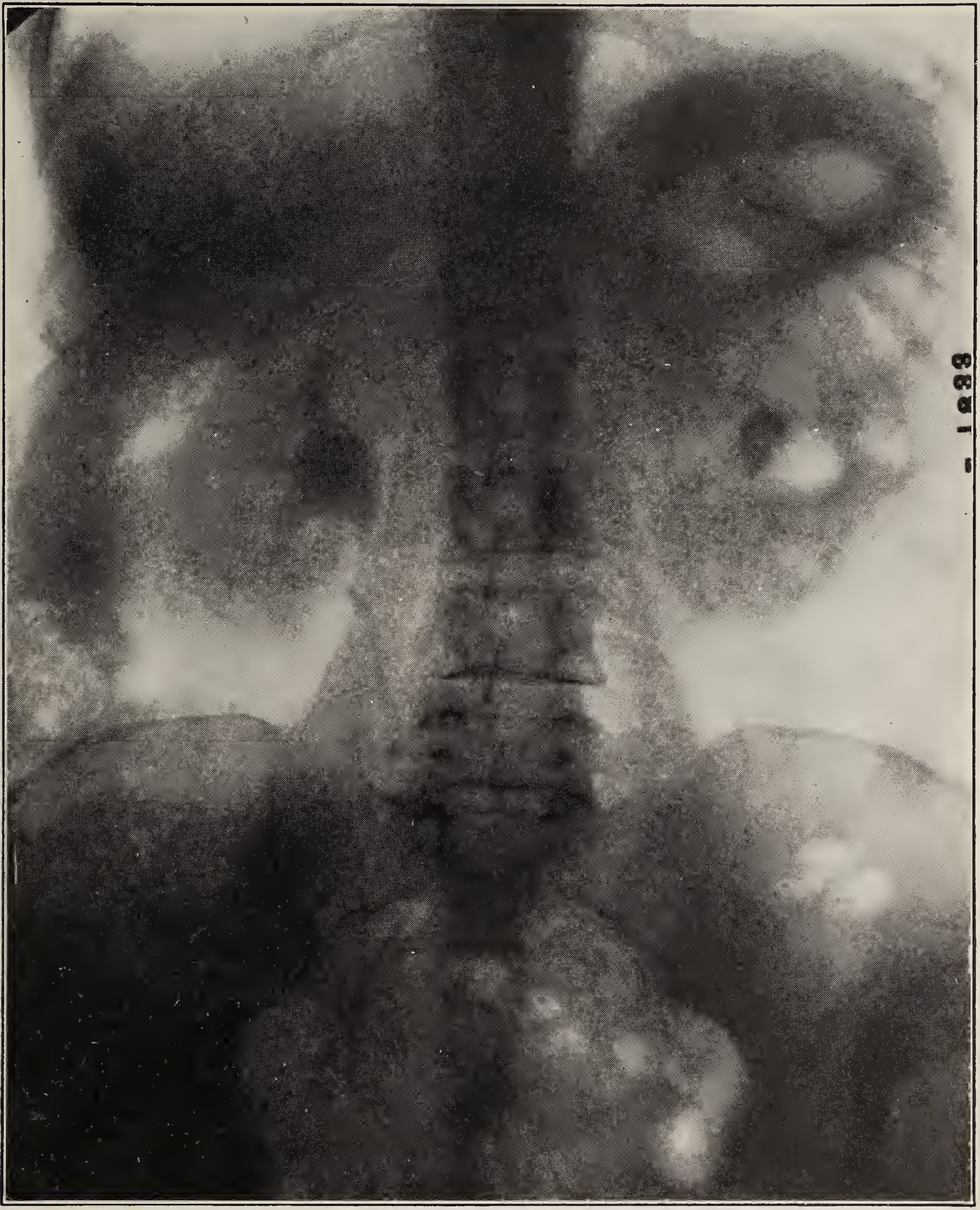

FIG. 26. Intravenous urogram demonstrating non-functioning calculus pyonephrosis of left kidney in a woman aged 54, admitted for left loin pain and pyuria. Right side normal.

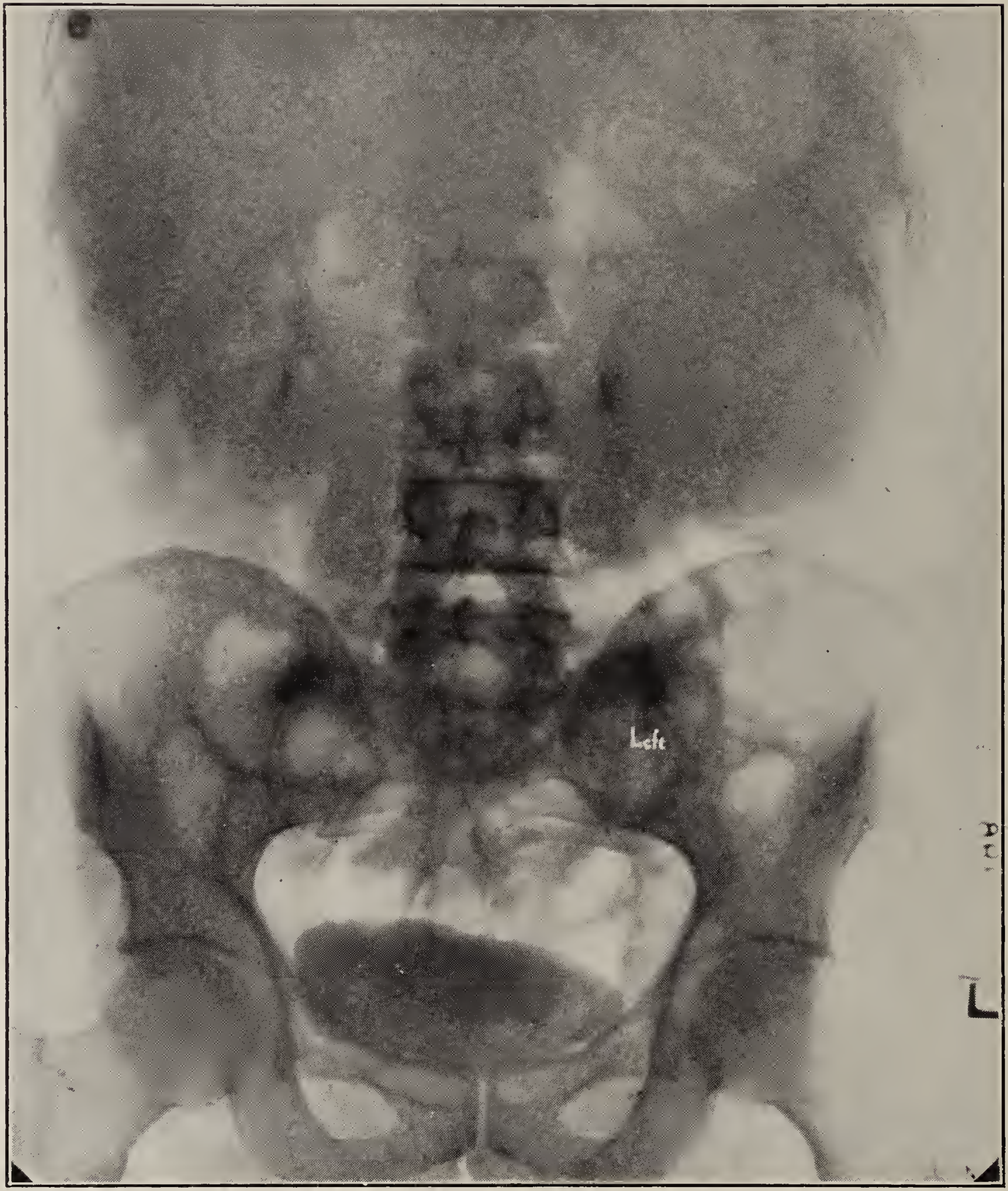

Fig. 27. Intravenous urogram, man aged 54, admitted for loss of weight and strength, anorexia and intermittent left kidney pain. (Patient refused cystoscopy.) Shows normal right urinary tract. Left kidney pelvis and lower calix compressed, filling defect of middle and upper calices. Diagnosis and operative findings — hypernephroma of left kidney.

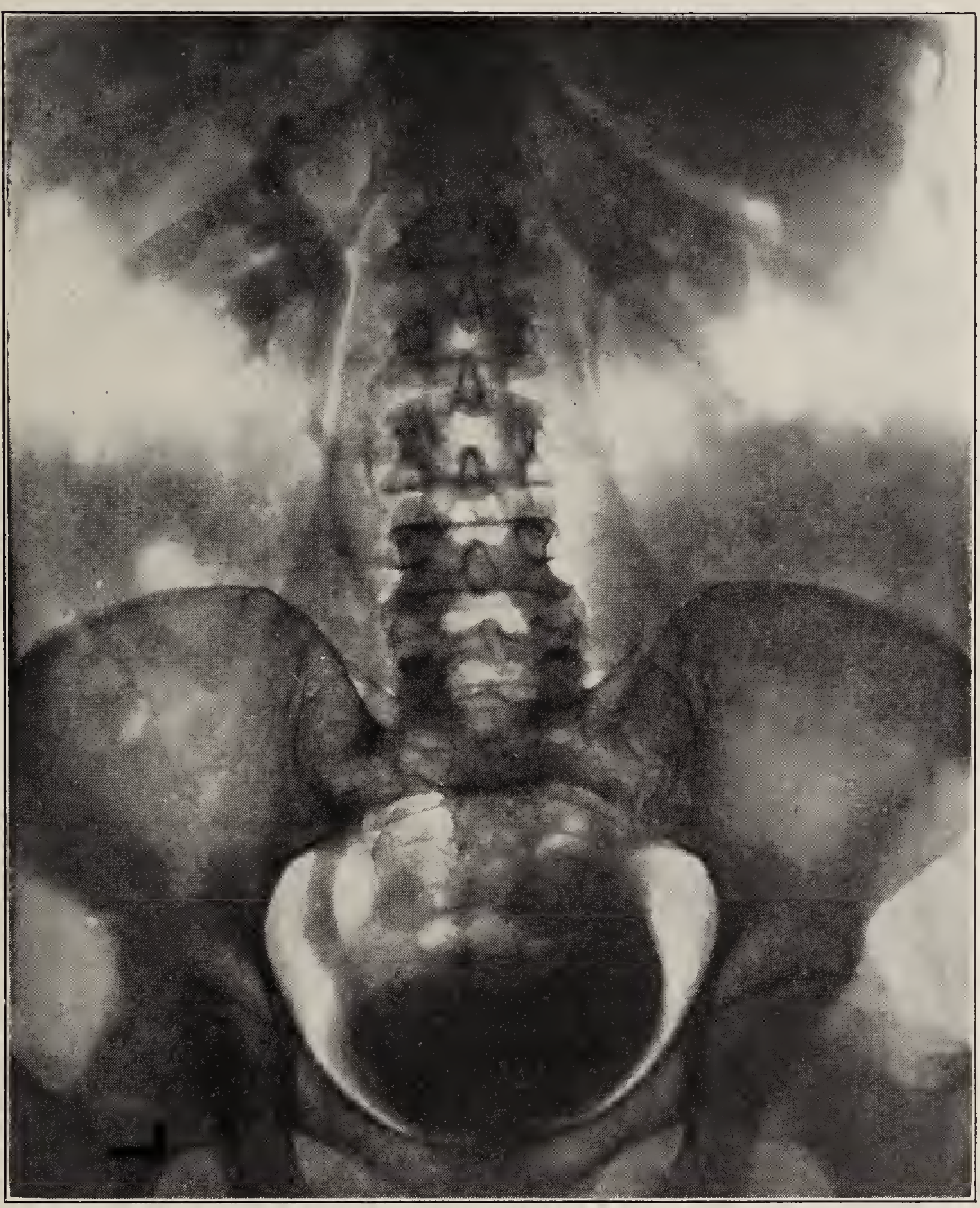

FIG. 28. Intravenous urogram, woman aged 62. Shows normal right side. Dilatation of left urinary tract, especially of juxta- and intra-vesical portions of ureter and a filling defect of left side of bladder. The denser shadow on the left as compared to that on the right side is due to partial obstruction at the left ureteral orifice. Cystoscopically, a *papillary carcinoma of urinary bladder* extending from left orifice to internal sphincter was found — left ureteral orifice could not be seen, no indigo carmine excretion from that side. (Courtesy of the Journal of the American Medical Association.)

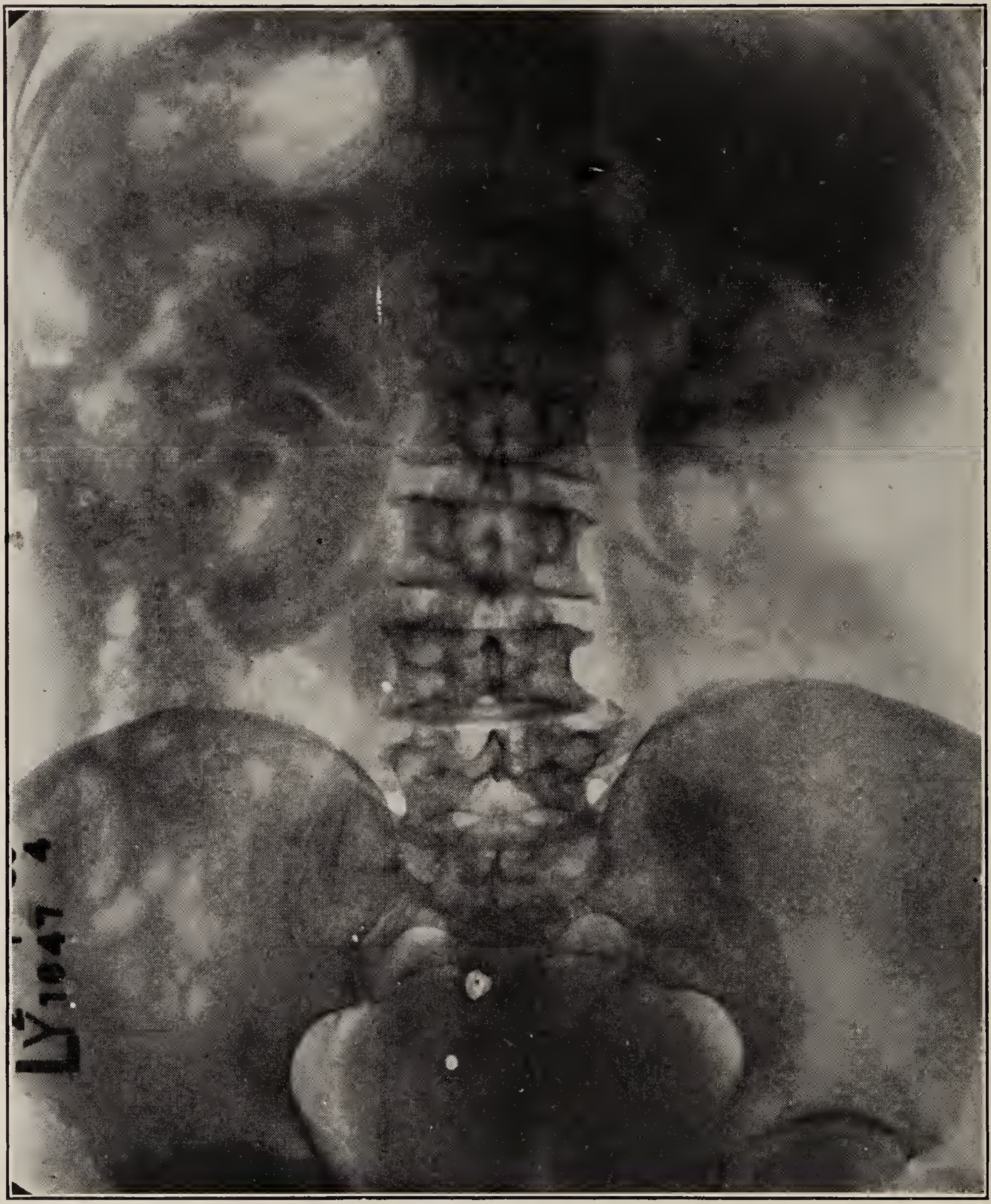

FIG. 29. Intravenous urogram of a man, aged 63, demonstrating bilateral dilatation and tortuosity of both upper urinary tracts, more marked on the left side (previous ureterotomy for left ureter stone), incidental to an hypertrophied prostate. Complete visualization was delayed.

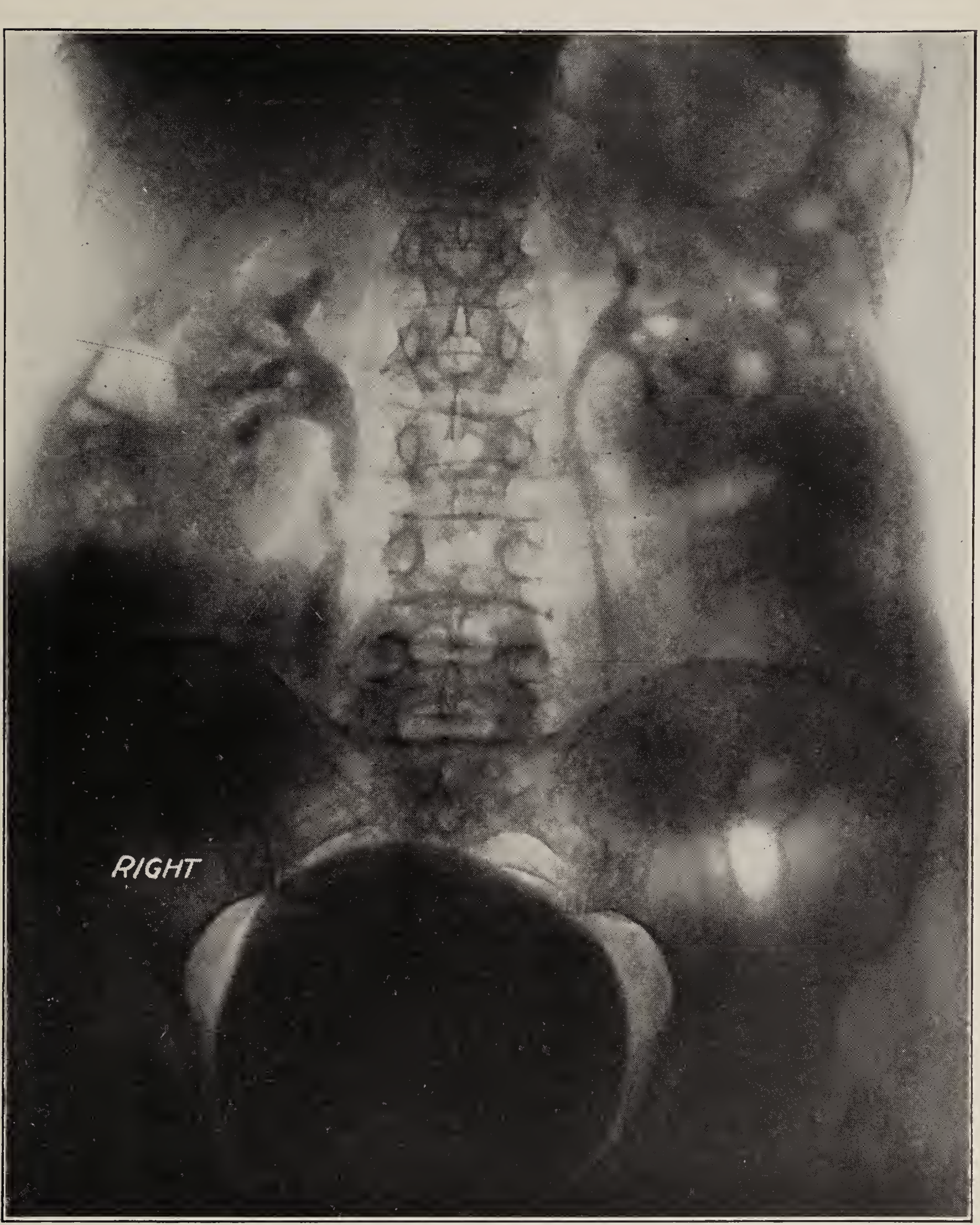

FIG. 30. Intravenous urogram to exclude a right-sided abdominal neoplasm in a woman, aged 48. Demonstrates ptosed kidney, ureteral kink with dilatation. (Courtesy of the Journal of the American Medical Association.)

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THE SCROTUM

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THE SCROTUM

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ANATOMY

Immediately below the symphysis pubis in the midline is a pouch in which rest the testicles. Each testicle is covered by a series of layers which join to form the scrotal septum. There are six principal layers which cover the testicle, but the skin itself is the only one which crosses the midline. From each side the dartos comes into contact but does not cross.

The Skin. The scrotal integument is pigmented and covered by scattered hairs, and contains many sebaceous and sudoriparous glands. In the midline is a longitudinal raphe from which a great many transverse wrinkles originate.

The Dartos is a reddish layer adherent to the under surface of the integument. It is composed of unstriped muscle fibers running longitudinally, which throw the normal skin into transverse folds when it contracts. During mental emotion or exposure to cold the dartos muscle contracts, decreases the size of the scrotum, and increases the size of the transverse ridges. In general debility or in complete relaxation the dartos muscles lengthen and allow the skin to become quite smooth. A few of the more superficial fibers cross the septum, but the majority bend inward and meet the corresponding layer of the opposite side.

The Cremasteric Fascia is a thin layer of connective tissue immediately under and adherent to the dartos. It is the continuation downward of the intercolumnar fascia from the external abdominal ring. It is continuous with the deep layer of the superficial perineal fascia and also with the deep layer of the superficial fascia of the abdomen (Scarpa's fascia).

External Cremasteric Muscle. This is immediately below the cremasteric fascia and consists of a double lamina of areolar and elastic tissue enclosing and connecting longitudinal bundles of striped muscle, and can be traced upward to the external abdominal ring. Here the fibers collect in two bands, one to be attached to the pubic spine and the second to the lower border of the internal oblique muscle.

Tunica Vaginalis Communis. This is a continuation downward of the fascia transversalis. It is a thin, connective tissue layer, which is also called the internal spermatic or infundibuliform fascia.

Tunica Vaginalis Propria. This layer is intimately connected with the tunica vaginalis communis and is composed of adipose tissue, elastic fibers, and a number of non-striped muscle fibers. It is a serous sac of peritoneal origin with parietal and visceral layers, the parietal layer being the thicker.

Blood Vessels, Lymphatics, and Nerves. The skin and scrotum are supplied by the anterior and posterior scrotal *arteries,* branches of the femoral and internal pudic. The deep layers receive a special branch from the epigastric. The *veins* drain into the corresponding vessels, the epigastric, long saphenous, and pudic. The *lymphatics* drain to the internal nodes of the inguinal glands. The *nerves* come from the genitocrural and superficial perineal.

EMBRYOLOGY

In its migration, the testicle pushes the layer of the abdominal wall before it and comes to rest outside the abdominal cavity in the genital swelling of the same side. By the fourth month, the genital swellings fuse in the midline to form the median raphe, and this completes the scrotum.

HYDROCELE

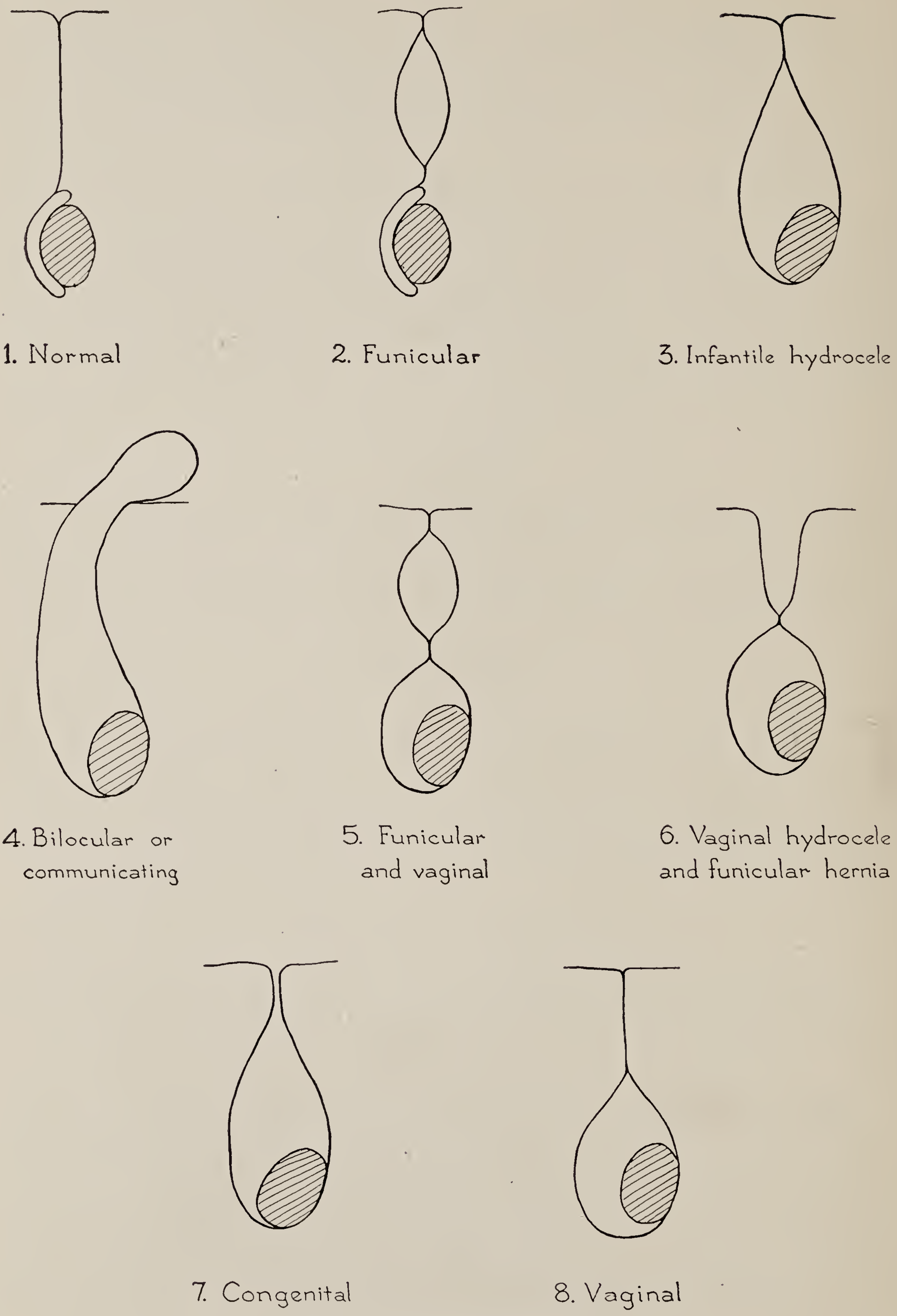
A hydrocele is a collection of fluid in the tunica vaginalis or in some adjoining portion of the funicular process. The fluid in a hydrocele may be serum, spermatozoa, or, in a few rare instances, chyle.

There are two main varieties of hydrocele which may be considered, according as they arise in the *testis* or in the *cord.*

(*a*) Hydrocele of the Testis

In this form the fluid may be present in the tunica vaginalis or be an encysted swelling in its neighborhood. The vaginal hydroceles occur in several varieties.

Acute Hydrocele. Each time one sees an acute inflammation of the epididymis it is difficult to outline the testicle. A small quantity of fluid collects in the tunica vaginalis and prevents one from feeling the testicle directly and obtaining the characteristic testicular sensation present on pressure. The fluid is plasma, which is found in all acute inflammations of the serous membranes. It is spontaneously coaguable, may become chronic and remain, or may entirely disappear leaving only a few adhesions.



1. Normal
2. Funicular
3. Infantile hydrocele
4. Bilocular or communicating
5. Funicular and vaginal
6. Vaginal hydrocele and funicular hernia
7. Congenital
8. Vaginal

Fig. 1. Types of hydroceles.

Acquired or Vaginal Hydrocele. (See Fig. 1) This is the common variety of hydrocele found when fluid fills the tunica vaginalis. It may occur from no apparent cause, but is usually secondary to some form of irritation such as an epididymitis or orchitis. It nearly always accompanies a tertiary syphilitic enlargement, but is rarely found in tuberculosis or in new growths. A neoplasm which invades the tunica vaginalis may form a hydrocele with the exudation of a large quantity of fluid which at times may be bloody.

People who dwell in a hot climate, such as India, frequently have hydroceles. They may be due to the lax and pendulous scrotum which the natives always support.

The tunica may be very much thickened in long-standing hydroceles, which may have been tapped several times. Fibrinous exudate may be present on the surface of the tunica. The wall of the hydrocele may contain thick plaques of fibrous material, sometimes yellowish from fatty degeneration; may be calcified, cartilaginous, or even osseous.

Adhesions form between the testis and the parietal layer of the tunica vaginalis as a result of inflammation and divide the cavity into compartments. This forms the loculated hydrocele which is so difficult to tap, as the needle empties one compartment only. It may be a constant source of annoyance due to a dull, dragging pain and the weight of the swelling.

Signs. A swelling in the scrotum, caused by a collection of fluid in the tunica vaginalis, is pyriform in outline and confined to either one side or the other. Occasionally it is bilateral, but not often. The tension varies according to the quantity of fluid. It fluctuates and has an elasticity. The testis is situated posteriorly and below, while the cord is situated above the upper, rounded portion of the hydrocele. The swelling is translucent, but this varies according to the thickness of the walls and the amount of fluid present. Translucency is found quite easily in a small hydrocele, while it is more difficult with a large, old hydrocele containing a large quantity of fluid and having thickened walls. It is demonstrated by placing a small electric light posterior to the swelling and the mass is observed through a funnel improvised from a newspaper, a magazine, or some other handy article. If translucency is tested in a dark room it is not so important to use the funnel, but the eyes can be shaded from the light with the hand close to the light and against the scrotum. No impulse can be felt on coughing and the percussion note is dull.

Hydrocele fluid is thin, clear, and often amber color. Its specific gravity varies from 1015 to 1025. It contains a large amount of albumin, most of which is fibrinogen. The reaction is neutral. A fair amount of salts is present in the form of alkaline carbonates and chlorides. Very old hydroceles may contain cholesterin. Hydroceles which have been tapped several times may have bacteria and red blood cells present.

Treatment. Palliative: This consists in tapping or in the use of a suspensory. A suspensory bandage is very useful to support the enlarged scrotum. The hydrocele is an extra weight in the scrotum, which is more comfortable when it is supported.

Tapping a hydrocele is used as a palliative method for the release of the fluid from the sac. One bears in mind that the testicle is situated posteriorly at the lower pole of the sac, and selects a point on the lower part of the anterior surface, avoiding any blood vessels which can be seen. The needle or the trocar and cannula are plunged through the scrotal wall until the point of the needle is in the lumen of the hydrocele sac. A syringe is attached to the needle and the fluid withdrawn. The trocar is withdrawn from the cannula and the fluid allowed to run out. It may be necessary to exert pressure on the scrotum both with the needle and with the trocar and cannula, to get out most of the fluid. The fluid usually recurs following tapping. Sometimes it returns in a few days, or it may take several months. An injury to a blood vessel may cause the sac to fill with blood. Then one would be dealing with a hematocele.

Several reagents are used for injection following the removal of the fluid. A real irritant is used which will produce an intense inflammation, to be followed by adhesions and obliteration of the cavity. Some of these are: Glycerin of carbolic acid, tincture iodine, Port wine, solution of mercuric chloride 1:500. The tincture iodine is a 4 per cent. solution using two teaspoonfuls, and is probably the best. It produces a strong inflammatory reaction and is followed by adhesions and obliteration of the cavity of the hydrocele. This will fail if the walls are too thick and indurated or if the solution is too weak.

Radical or Operative: There are two methods in common usage: (1) simple inversion of the tunica vaginalis, the "bottle operation," or (2) the excision of the whole sac.

(*a*) **Inversion, or the Bottle Operation.** The incision is made over the upper part of the scrotum immediately below the external abdominal ring. This is carried down to the tunica vaginalis. It is recognized as a "blue" layer, through which the fluid in the tunica vaginalis can be seen. The finger is inserted into the line of cleavage between this and the other layers in the scrotum and swept around until the whole sac is separated from the outer layers. The sac is incised and the fluid allowed to escape. The opening is enlarged and the testicle brought out through the opening and the sac inverted. Its cut margins are fastened by one or two interrupted sutures, and the testicle and sac returned to the scrotum.

(*b*) **Excision of the Tunica Vaginalis** is carried out in those cases where there is a very much thickened sac. The tunica is separated from the surrounding structures in the same way as with a thin sac. The sac is cut away from the epididymis and testicle, and dissected free from the cord above. Great care must be exercised in its separation from the cord to avoid injury to the blood vessels. All bleeding points are caught, tied, or oversewn, taking great care to control all bleeding.

A piece of rubber tissue or a small rubber tube is inserted down to the bottom of the scrotum to give exit to any blood, and the wound closed by a subcuticular catgut suture. The subcuticular closure is very useful, as it obviates the necessity of hunting for buried skin sutures in the corrugated skin of the scrotum.

The incision may also be made over the external abdominal ring. Some prefer this to making an incision in the scrotum itself. The sac is reached by pushing it up from below at the same time as the dissection from above is carried toward the scrotum. The other steps are similar to those when the incision is made over the upper part of the scrotum.

Following these operations the tube is withdrawn in twenty-four hours. The scrotum is well elevated. A fair amount of swelling and edema is found in the scrotum, which subsides gradually, as does also the swelling in the scrotum in the position of the cut tunica vaginalis.

Infantile Hydrocele. This is due to a non-obliteration of the funicular process except at its upper end, and later to a collection of fluid in the common cavity of the tunica vaginalis. It is diagnosed by finding the fluid in the tunica vaginalis continuing as a long, fluctuant swelling up toward the inguinal canal and extending into it.

Treatment. This hydrocele is tapped or treated by operation, the same as in vaginal hydrocele.

Congenital Hydrocele is a collection of fluid in the sac, which has a patent funicular process. By pressure the fluid returns to the abdominal cavity. This is present mostly in infants, and may be the forerunner of a congenital hernia.

Treatment. Elevation and open operation are carried out. In the open operation the peritoneum is closed, as with an indirect hernia.

Bilocular or Communicating Hydrocele. Occasionally there is a persistent funicular process distended with fluid, communicating below with the tunica vaginalis and above with a sac pushed through the inguinal canal to form an extraperitoneal sacculus but inside the internal abdominal ring. This is really an infantile hydrocele in which the funicular process has burrowed up through the inguinal canal to form a loculus inside the abdominal wall. It may burrow downward toward the bladder. This condition can be present in the female, having arisen from the upper portion of the canal of Nück.

Acute Hydrocele of Infants. There may be an acute swelling which suddenly appears in the tunica vaginalis of infants, and the child appears acutely ill. It is difficult to diagnose from a strangulated hernia. The patient will pass feces and flatus, have no vomiting, and in a short time the child will return to his food. This is an indulgence which a child with a strangulated hernia will not do. A further point in making a differential diagnosis is to aspirate the fluid in the sac.

Encysted Hydrocele of the Testis occurs in two main forms, the one arising from the *testicle* and the other from the *epididymis.*

(*a*) **Encysted Hydrocele of the Epididymis.** These are fairly common. They are also called Cysts of the Epididymis and Spermatoceles. A cystic swelling occurs at the upper pole of the testicle, which does not get larger than a tangerine. It looks very much as if two testicles were present on that side but the testicular sensation is absent over the cysts of the epididymis.

The fluid in these cysts is milky and opalescent, due to the presence of seminal fluid containing spermatozoa, either living or dead. Very little albumin is present and the specific gravity is lower than that of hydrocele fluid. These cysts are lined by a cuboidal or columnar epithelium in place of the endothelium of the tunica vaginalis. They are derived from a dilatation of the vasa efferentia or from a distention with fluid of one of the many fetal remains present at the upper pole of the epididymis, especially Kobelt's tubules. The vasa efferentia and Kobelt's tubules are derived from the Wolffian body, but differ from them by not becoming attached to the body of the testicle.

There are some smaller cysts on a pedicle found here, which are probably due to distention of the hydatid of Morgagni, the remains of the Müllerian duct.

Treatment. They are rarely sufficiently large to cause any trouble from their weight and size, and can be left alone. If it should be necessary, they can be removed by dissecting the whole sac free, using either the inguinal or scrotal route.

(*b*) **Encysted Hydrocele of the Tunica Albuginea.** These are very rare and due to a small collection of fluid under the visceral layer of the tunica vaginalis. They are said to be due to dilatation of the lymph spaces.

Chylous Hydrocele. The tunica vaginalis is filled with a milky fluid called chylous fluid, found to be a fatty emulsion of unknown origin. Dilated lymphatics are associated with it. In one case a group of dilated lymphatics was seen extending from the testicle upward toward the inguinal canal. It accompanied lymph scrotum. Filarial embryos may be found in the fluid if it accompanies a filarial lesion. It does not transmit light.

These hydroceles are treated the same as hydroceles of the tunica vaginalis, either by excision of the sac or aspiration of the tunica vaginalis.

(*b*) Hydrocele of the Cord.

Hydrocele is present in the cord in company with the congenital and infantile types of vaginal hydrocele. When it is limited to the cord it has two forms: the *encysted* and the *diffuse.*

Encysted Hydrocele of the Cord. There is a persistence of the funicular process of the peritoneum, which becomes filled with fluid and lined by endothelium. This is a rounded or sausage-shaped swelling, which presents the signs of a sac filled with fluid. It will move up and down until the testicle becomes fixed, when it becomes stationary also. There may be a similar hydrocele in females, due to an imperfect obliteration of the canal of Nück.

Treatment. This is similar to that used in vaginal hydrocele, namely: tapping, injection, or complete excision.

Diffuse Hydrocele of the Cord is a rare form caused by diffuse edema of the cord. It is a diffuse or sausage-shaped tumor which extends along the cord for a variable distance.

INFLAMMATIONS

Various organisms may infect the skin of the scrotum or the area deep under the surface.

An inflammatory lesion in the skin proper is usually of staphylococcic origin, and exhibits the usual signs of heat, redness, pain, swelling, and edema. The very loose structure of the skin makes swelling and edema very marked.

Organisms may be implanted as deep as Colles' fascia, and cause a marked inflammatory reaction and spread over the whole scrotum, backward to the perineum and upward on the anterior abdominal wall. They are prevented from spreading down the thigh by the attachment of the deep layer of the superficial fascia of the abdomen (fascia of Scarpa) to the fascia of the thigh one inch below the inguinal ligament. Similarly, urine extravasated from a ruptured membranous urethra spreads under Colles' fascia over the scrotum and up the abdominal wall. Swelling of the scrotum and area under the arch of the pubes suggests the presence of some inflammatory process under Colles' fascia.

Suppurative orchitis may involve the skin over the scrotum, soften and rupture, discharging pus. This occurs more frequently with tuberculous epididymitis. The treatment of these conditions is free incision and drainage. If a wide area is involved, multiple incisions are necessary.

ACUTE STREPTOCOCCIC CELLULITIS

Acute streptococcic cellulitis may begin in all the layers of the scrotum and quickly advance, causing redness, edema, gangrene, and death of the patient in rapid succession. The edema spreads to the skin over the penis, and a hard, dark red, leathery infiltration takes place in the skin up the abdomen and down the thighs. This swelling of the skin is similar in consistence to erysipelas, but there is not the same sharply defined advancing border. An incision in this area lies open and bleeds very little. The skin of the scrotum becomes gray and finally black as this tender area melts away before the onset of such an acute and rapidly advancing process. Marked constitutional symptoms, such as malaise, weakness, high fever, and a rapid pulse, accompany this infection, and the patient succumbs in a few days.

TUBERCULOSIS OF THE SCROTUM

A tuberculous infection of the scrotum is secondary to a tuberculous epididymitis. An abscess forming in the epididymis gravitates to the lower and posterior portion of the epididymis, and the visceral and parietal layers of the tunica vaginalis become adherent. A swelling appears in the skin, the rugæ disappear, and a fluctuating area varying in size bursts, discharging its contents of caseous material. When the pus has been emptied from the abscess cavity, a sinus remains for a varying time and finally closes. The scar of the sinus is adherent to the deeper structures and to an indurated epididymis. The sinus or scar is usually diagnostic of tuberculosis. A sinus in front of the scrotum means syphilis, while a sinus at the lower pole or behind means tuberculosis — Reclus' sign. One must be sure that there is no torsion of the epididymis.

SYPHILIS OF THE SCROTUM

Primary syphilis of the scrotum occurs as a chancre. It may be in the form of a circular erythematous patch, which later desquamates and leaves some small fissures from which serum exudes. The fissures coalesce, forming the typical chancre: a small, circular, depressed ulcer on a hard base with hard, indurated edges. The primary infection may be in the form of dried crusts which reform when they are removed.

The tertiary lesion affects the scrotum secondary to the gumma of the testicle. This lesion may ulcerate the anterior surface of the scrotum and form a discharging ulcer with a deep base and hard, punched-out edges.

The treatment of these lesions is the general systemic treatment of syphilis.

CARCINOMA OF THE SCROTUM

Epidermoid carcinoma of the scrotum, or " chimney-sweep's cancer," is a striking example of the relation which exists between chronic irritation and cancer. The constant irritation of soot to the skin of the scrotum produces warty excrescences, which later are the seats of malignancy. The skin becomes hard, dry, thickened, and indurated. It is suggested that the arsenic present in the soot is the irritant leading to the formation of cancer. The appearance of the skin is very similar to that of an arsenic dermatitis, and Hutchinson's case of arsenic cancer occurred in the skin of the scrotum. In others, an epidermoid carcinoma develops in the skin without any history of irritation by soot. One of these, seen by the writer, was in a farmer who had not had an exposure to soot or arsenic to cause any local irritation.

The growth will ulcerate, leaving a grayish slough at the base with hard heaped-up edges. The mass is irregular in outline and rapidly involves the inguinal glands.

Treatment. Treatment consists of wide local excision of the mass and complete excision of the inguinal glands, whether they are palpably involved or not. It is most important that the whole inguinal gland bearing areas of both sides should be removed. Radium in the form of platinum needles or packs has not been found to cure. Similarly, large doses of high-voltage x-rays have not cured these conditions. Wide excision, with the implantation of radium needles, done as early as possible, has been found most efficacious.

SEBACEOUS CYSTS

Multiple sebaceous cysts are found over the whole area of the scrotum. They occur in a variety of sizes, from that of a pin-head to the size of an almond. The skin covering them is smooth and light yellowish in color from the caseous material of the cyst showing through.

BLOOD CYSTS

Multiple dark blue blood cysts are described by Keyes. They occur after middle life and cause no symptoms to the patient except the annoyance of their presence. They can be cured by pricking and burning them with an electrode or a silver nitrate cautery.

TRAUMA

An injury to the scrotum may cause considerable hemorrhage within the layers of the scrotum. Blood which collects in the scrotum may be very extensive and may warrant the term *hematoma scroti*. Incised wounds are also seen, and are treated as any other wound.

ELEPHANTIASIS OF THE SCROTUM

This is a manifestation of filariasis more prevalent in Cochin-China and Samoa, though it is distributed over most tropical countries. It is the condition found following obstruction in the lymph stream after an attack of fever and lymphangitis. The lower extremities, scrotum and vulva, are involved frequently, although other parts may be subject to the same condition. When the first attack occurs and the lymph return of the scrotum is shut off, there is a slight enlargement and a heavy feeling. The skin feels thickened, with here and there hair follicles or some small vesicles which exude a milky fluid when broken. Another attack of lymphangitis occurs, leaving the scrotum larger, heavier, and the skin thicker. With each successive attack the scrotum increases in size until it reaches enormous proportions. Some have been seen which weighed over two hundred pounds. The loose skin of the lower abdomen, thighs, and perineum is included in the gradual swelling of the scrotum. The skin of the penis is also involved. The prepuce becomes drawn down over the upper surface of the mass and is represented by a funnel which leads up to the glans. The body of the penis may be found with great difficulty in the upper surface of the mass.

Treatment.[1] " In cases involving the scrotum and in which the penis is entirely hidden, the mass must be freely incised from well above the symphysis pubis to the opening of the preputial funnel, and the enormous penis and spermatic cords up the external ring, cleanly enucleated, the thickened gubernacula being divided below in order to free the cords. The penis, cords and testes in their tunica vaginalis are turned up on to the abdomen out of harm's way, the urethra is guarded by a catheter placed in it, and the mass amputated. Every particle of diseased skin and subcutaneous tissue is dissected away and the muscles are laid bare. The flaps of healthy skin that remain are undercut to form a pouch for the testes. The cords and tunicæ are now cleared of disease by careful dissection and the testes placed in the pouch made for them. Generally most of the penis is left bare and is subsequently grafted.

If only the scrotum is affected, the operation is much easier, the cords and testes being first dissected out, and the mass removed as described above."

CAVERNOUS HEMANGIOMA OF THE SCROTUM

Winslow of Baltimore observed a patient, seventeen years of age, who had a lump the size of an orange in the scrotum and extending upward along the cord. It felt like a bag of blood vessels, though no bruits or pulsation could be heard on auscultation. This lump was removed at operation.

Many other rare tumors and lesions may occur on the scrotal skin in the same way as they may appear on the skin of any part of the body.

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